North Carolina Department of Transportation
Division of Highways
Statewide Planning Branch

HENDERSON THOROUGHFARE PLAN

– 1995 –

THOROUGHFARE PLAN

FOR

HENDERSON, NORTH CAROLINA

Prepared by the:

Statewide Planning Branch
Division of Highways
N. C. Department of Transportation

In Cooperation with:

The City of Henderson
County of Vance
The Federal Highway Administration
U. S. Department of Transportation

1995

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ACKNOWLEDGMENTS

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I. INTRODUCTION

This report documents the findings of a study for the Henderson Planning Area. The study was initiated in July, 1993 and culminated in the mutual adoption of a Thoroughfare Plan for the Henderson Planning Area (Shown in Figure 8 on a map dated October 6, 1994).

The purpose of this study was to examine the present and future transportation needs of the area, and from this derive a Thoroughfare Plan. The system of thoroughfares proposed was developed following the principles of thoroughfare planning outlined in Chapter II of this report.

The recommended cross-sections resulting from the study are based on existing conditions and the expected volume of traffic in the design year. Before a project is implemented a more detailed evaluation will be performed to ensure that changing conditions have not altered the recommendations. Every effort was made to use as much of the existing street system as possible in order to minimize cost and environmental disruption. The location of new facilities was based on field investigation, existing land use, and topographic conditions.

Initiative for plan implementation will rest largely with the policy boards and citizens of the area. The scope of highway needs throughout the State greatly outweigh the available funding. It is, therefore, necessary that the local areas aggressively pursue funding for desired projects.

Responsibility for the proposed construction must be shared by City of Henderson and the North Carolina Division of Highways. With the different governmental agencies involved in providing the elements of the plan, coordination of activities is of prime importance. The plan is formally adopted by both the local governing bodies and the North Carolina Board of Transportation, to serve as a mutual official guide in providing a well coordinated, adequate, and economical major street system. In order for the plan to be effective, the City of Henderson and the State must procure in advance or protect by various legal controls the rights-of-way necessary for the improvements which will ultimately be required.

It must be emphasized that the Thoroughfare Plan was based on anticipated growth of the urban area, as provided by City of Henderson. Actual growth rates and patterns may differ from those anticipated and it may become necessary to accelerate or retard the development of thoroughfares or to make revisions in the proposed plan. It is desirable to review the plan in detail approximately every ten years to adjust the thoroughfare system to reflect the actual rate of growth and type of development.

GEOGRAPHIC LOCATION FOR HENDERSON NORTH CAROLINA

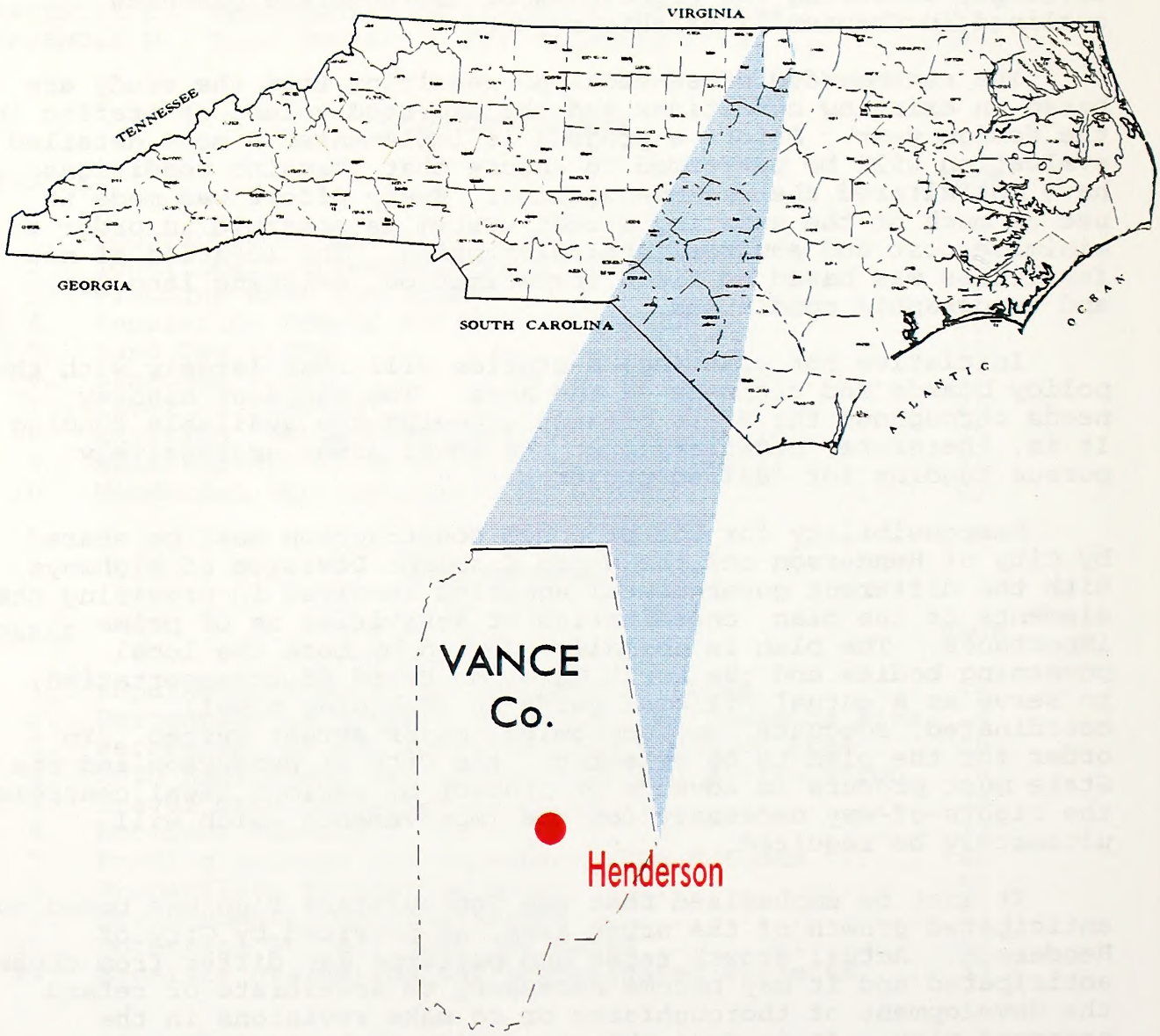


FIGURE 1

II. THOROUGHFARE PLANNING PRINCIPLES

Objectives

Typically, the urban street system occupies 25 to 30 percent of the total developed land in an urban area. Since the system is permanent and expensive to build and maintain, much care and foresight are needed in its development. Thoroughfare planning is the process public officials use to assure the development of the most appropriate street system that will meet existing and future travel desires within the urban area.

The primary aim of a thoroughfare plan is to guide the development of the urban street system in a manner consistent with the changing traffic patterns. A thoroughfare plan will enable street improvements to be made as traffic demands increase, and it helps eliminate unnecessary improvements, so needless expense can be averted. By developing the urban street system to keep pace with increasing traffic demands, a maximum utilization of the system can be attained, requiring a minimum amount of land for street purposes. In addition to providing for traffic needs the thoroughfare plan should embody those details of good urban planning necessary to present a pleasing and efficient urban community. The location of present and future population, commercial and industrial development affects major street and highway locations. Conversely, the location of major streets and highways within the urban area will influence the urban development pattern.

Other objectives of a thoroughfare plan include:

1. providing for the orderly development of an adequate major street system as land development occurs,

2. reducing travel and transportation costs,

3. reducing the cost of major street improvements to the public through the coordination of the street system with private action,

4. enabling private interests to plan their actions, improvements, and development with full knowledge of public intent,

5. minimizing disruption and displacement of people and businesses through long range advance planning for major street improvements,

6. reducing environmental impacts, such as air pollution, resulting from transportation, and

7. increasing travel safety.

Thoroughfare planning objectives are achieved through (1) improving the **operational efficiency** of thoroughfares; and (2) improving the **system efficiency** through system coordination and layout.

Operational Efficiency

A street's operational efficiency is improved by increasing the capability of the street to carry vehicular traffic and people. In terms of vehicular traffic, a street's capacity is defined as the maximum number of vehicles which can pass a given point on a roadway during a given time period under prevailing roadway and traffic conditions. Capacity is affected by the physical features of the roadway, nature of traffic, and weather.

Physical ways to improve vehicular capacity include **street widening, intersections improvements, improving vertical and horizontal alignment,** and **eliminating roadside obstacles.** For example, widening of a street from two to four lanes more than doubles the capacity of the street by providing additional maneuverability for traffic. Impedances to traffic flow caused by slow moving or turning vehicles and adverse effects of horizontal and vertical alignments are thus reduced.

Operational ways to improve street capacity include:

1. **Control of access** - A roadway with complete control of access often carries three times the traffic handled by a non-controlled access street with identical lane widths and number of lanes.

2. **Parking removal** - Parking removal increases capacity by providing additional street width for traffic flow and reducing friction to flow caused by parking and unparking vehicles.

3. **One-way operation** - The capacity of a street can sometimes be increased 20-50%, depending upon turning movements and overall street width, by initiating one-way traffic operations. One-way streets can also improve traffic flow by decreasing potential traffic conflicts and simplifying traffic signal coordination.

4. **Reversible lanes** - Reversible traffic lanes may be used to increase street capacity in situations where heavy directional flows occur during peak periods.

5. **Signal phasing and coordination** - Uncoordinated signals and poor signal phasing restrict traffic flow by creating excessive stop-and-go operation.

Altering travel demand is a third way to improve the efficiency of existing streets. Travel demand can be reduced or altered in the following ways:

1. Encourage people to form **carpools** and **vanpools** for journeys to work and other trip purposes. This reduces the number of vehicles on the roadway and raises the people carrying capability of the street system.

2. Encourage the use of **transit** and **bicycle** modes.

3. Encourage industries, businesses, and institutions **to stagger work hours** or establish variable work hours for employees. This will reduce travel demand in peak periods and spread peak travel over a longer time period.

4. Plan and encourage **land use development** or redevelopment in a more travel efficient manner.

System Efficiency

Another means for altering travel demand is the development of a more efficient system of streets that will better serve travel desires. A more efficient system can reduce travel distances, time, and cost. Improvements in system efficiency can be achieved through the concept of functional classification of streets and development of a coordinated major street system.

Functional Classification

Streets perform two primary functions--traffic service and land service--which when combined, are basically incompatible. The conflict is not serious if both traffic and land service demands are low. However, when traffic volumes are high, conflicts created by uncontrolled and intensely used abutting property lead to intolerable traffic flow, side friction, and congestion.

The underlying concept of the thoroughfare plan is that it provides a functional system of streets which permits travel from origins to destinations with directness, ease, and safety. Different streets in the system are designed and called on to perform specific functions, thus minimizing the traffic and land service conflict. Streets are categorized as to function as local access streets, minor thoroughfares, or major thoroughfares (see Figure 2).

Local Access Streets provide access to abutting property. They are not intended to carry heavy volumes of traffic and should be located such that only traffic with origins and destinations on the streets could be served. Local streets may be further classified as either **residential, commercial, and/or industrial** depending upon the type of land use which the serve.

Minor Thoroughfares are more important streets on the city system. They collect traffic from local access streets and carry it to the major thoroughfares. They may in some instances supplement the major thoroughfare system by facilitating minor

through traffic movements. A third function that may be performed is that of providing access to abutting property. Minor thoroughfares should be designed to serve limited areas so that their development as major thoroughfares will be prevented.

Major Thoroughfares are the primary traffic arteries of the city. Their function is to move intra-city and inter-city traffic. The streets which comprise the major thoroughfare system may also serve abutting property; however, **their major function is to carry traffic.** They should not be bordered by uncontrolled strip development because such development significantly lowers the capacity of the thoroughfare to carry traffic; each driveway is a danger and an impediment to traffic flow. Major thoroughfares may range from a two-lane street carrying minor traffic volumes to major expressways with four or more traffic lanes. Parking normally should not be permitted on major thoroughfares.

Idealized Major Thoroughfare System

A coordinated system of major thoroughfare forms the basic framework of the urban street system. A major thoroughfare system which is most adaptable to desire lines of travel within an urban area and which permits movement between various areas of the city with maximum directness is the radial-loop system. This system consists of several functional elements--radial streets, crosstown streets, loop system streets, and bypasses (see Figure 2).

Radial streets provide for traffic movement between points located in the outskirts of the city and the central area. This is a major traffic movement in most cities and the economic strength of the central business district depends upon the ability of this type of thoroughfare to move traffic.

If all radial streets crossed in the central area, an intolerable congestion problem would result. To avoid this problem, it is very important to have a system of **crosstown streets** which form a loop around the central business district. This system allows traffic moving from origins on one side of the central area to destinations on the other side to follow the area's border and allows central area traffic to circle and then enter the area near a given destination. The effect of a good crosstown system is to free the central area of crosstown traffic, thus permitting the central area to function more adequately in its role as a pedestrian shopping area.

Loop system streets move traffic between outlying areas. Although a loop may completely encircle the city, a typical trip may be from an origin near a radial thoroughfare to a destination near another radial thoroughfare. Loop streets do not necessarily carry heavy volumes of traffic; they function to help relieve central areas.

IDEALIZED THOROUGHFARE PLAN

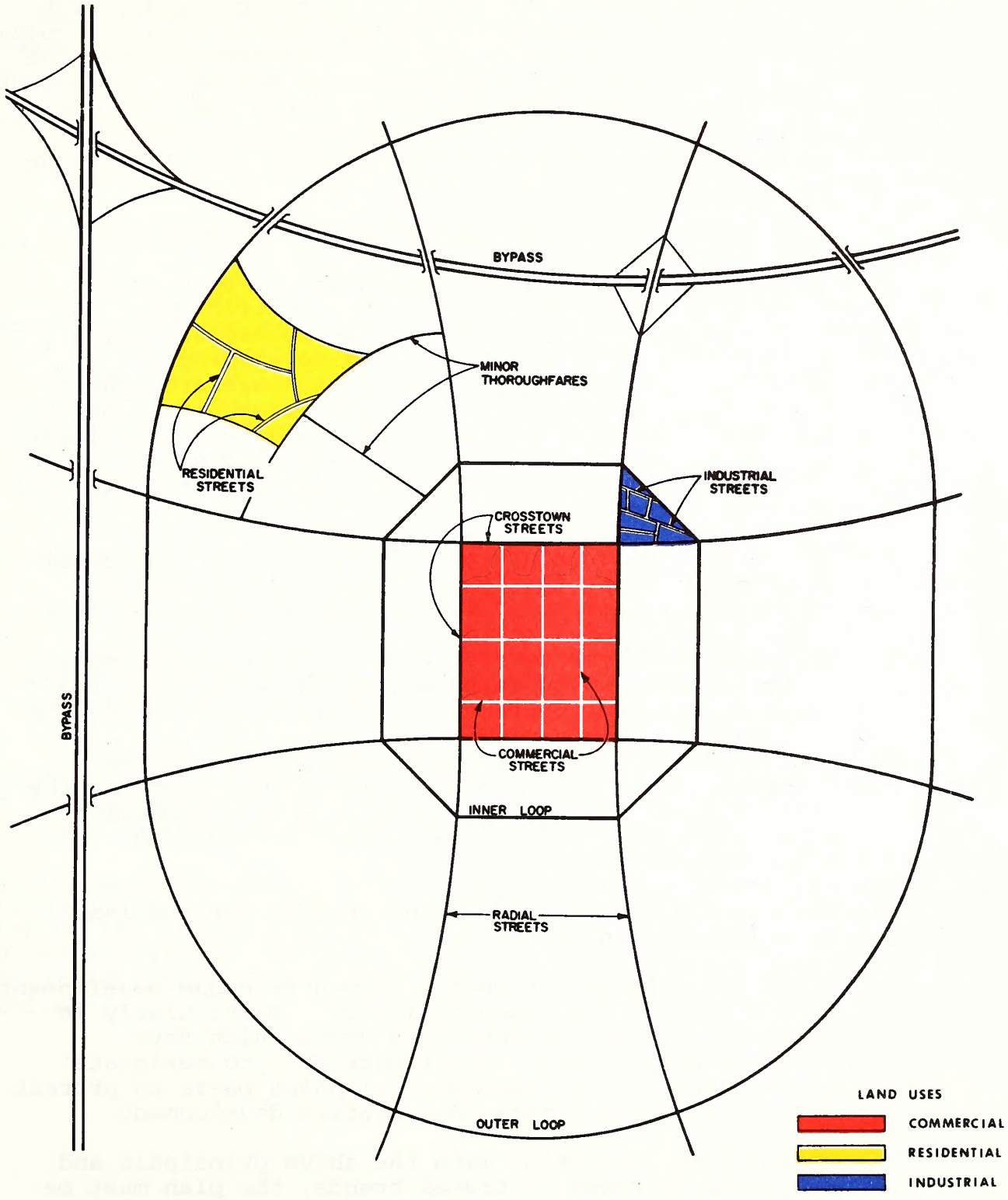


FIGURE 2

A **bypass** is designed to carry traffic through or around the urban area, thus providing relief to the city street system by removing from it traffic which has no desire to be in the city. Bypasses are usually designed to high-capacity standards, with control of access. Occasionally, a bypass with low traffic volume can be designed to function as a portion of an urban loop. The general effect of bypasses is to expedite the movement of through traffic and to improve traffic conditions within the city. By freeing the local streets for use by shopping and home-to-work traffic, bypasses tend to increase the economic vitality of the local area.

Application of Thoroughfare Planning Principles

The concepts presented in the discussion of operational efficiency, system efficiency, functional classification, and idealized major thoroughfare system are the conceptual tools available to the transportation planner in developing a thoroughfare plan. In actual practice, a thoroughfare plan is developed for established urban areas and is constrained by the existing land use and street patterns, existing public attitudes and goals, and current expectations of future land use. Compromises must be made because of these the many other factors that affect major street locations.

Throughout the thoroughfare planning process it is necessary from a practical viewpoint that certain basic principles be followed as closely as possible. These principles are as follows

1. The plan should be derived from a thorough knowledge of today's travel - its component parts, as well as the factors that contribute to it, limit it, and modify it.

2. Traffic demands must be sufficient to warrant the designation and development of each major street. the thoroughfare plan should be designed to accommodate a large portion of all major traffic movements on relatively few streets.

3. The plan should conform to and provide for the land development plan of the area.

4. Certain consideration must be given to urban development beyond the current planning period. particularly in outlying or sparsely developed areas which have development potential, it is necessary to designate thoroughfares on a long-range planning basis to protect right-of-way for future thoroughfare development.

5. While being consistent with the above principals and realistic in terms of travel trends, the plan must be economically feasible.

III. EXISTING AND PROJECTED CONDITIONS

The Planning Area - Historic Background

The area in which Henderson is located was originally part of a land grant by the King of England to the Earl of Granville. In 1780, the Revolutionary State of North Carolina laid claim to the area. A series of subdivisions of the grant into counties led finally in 1881 to the creation of Vance County. The already existing Town of Henderson, because of its size and central location, was designated as county seat.

By the early 1700's numbers of Scotch, German and Irish pioneer settlers had migrated into the area and well identified communities had begun to emerge. As agriculture, particularly tobacco, prospered, the Henderson-Vance County growth began in earnest due to its strategic location on east-west and north-south stage and wagon trails. With the construction of Raleigh and Gaston Railroad in 1835, the economic impetus was further accelerated. Local residents donated tracts of land on which the railroad built warehouses and shipping facilities. These, in turn, attracted merchants and others who built stores, homes, churches, stables, taverns, and schools all of which combined led to the charter and incorporation of the Town of Henderson in 1841. The town was named for chief justice Leonard Henderson, an outstanding colonial jurist and native of Henderson.

Recent years have seen educational improvements. In addition to its public schools, the area has two private schools as well as nearby Vance-Granville Community College, an institution dedicated to academic, technical and cultural learning at advanced levels.

Henderson sits astride main arteries of two major railroads. A major commercial airport is within forty miles and the city and the county share with the neighboring communities a local airport which can accommodate all but the larger aircraft.

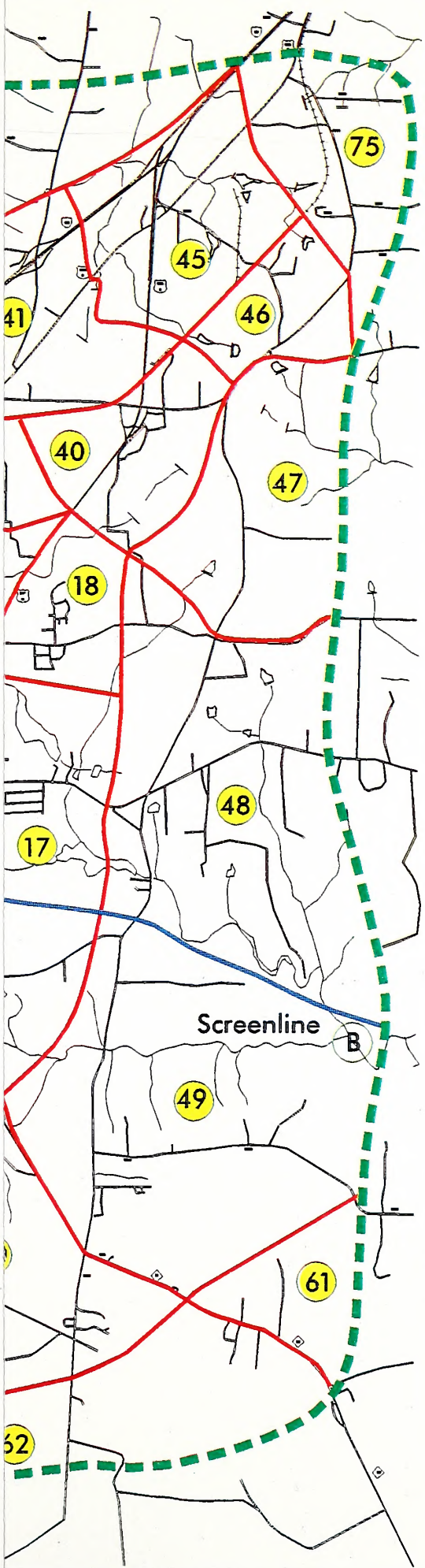
Henderson is proud of the enormous variety of manufacturing, merchandising, and service businesses available- attracted in large by the features of the location, mild climate, excellent medical facilities, churches, schools, water supply, recreational facilities, stable labor force, and outstanding municipal services.

Factors Affecting Transportation

The objective of thoroughfare planning is to develop a system of streets and highways which will enable people and goods to travel safely and economically. To determine the needs of a planning area, the factors of population, land use, and traffic must be examined. To properly plan for the transportation needs of the Henderson Planning Area, it is important to understand and describe the type and volume of travel which takes place in that area, and also to clearly identify the goals and objectives to be met by the transportation plan.

In order to fulfill the objectives of an adequate thirty year thoroughfare plan, reliable forecasts of future travel patterns must be achieved. Such forecasts are possible only when the following major items are carefully analyzed: (1) historic and potential population changes; (2) significant trends in the economy; and (3) character and intensity of land development. Additional items that vary in influence include the effects of legal controls such as zoning ordinances and subdivision regulations, availability of public utilities and transportation facilities, and topographic and other physical features of the area.

The first step in the development of the thoroughfare plan is to define the planning period and the planning area. The planning period is typically on the order of 20 years. The base year for the Henderson study was 1993, and the year 2020 was chosen to be the endpoint of the study period (27 years). The planning area is generally the limits to which some urbanization is expected to occur during the planning period. The planning area is then subdivided into traffic analysis zones. Figure 3 shows the planning area boundary and zones.



PLANNING AREA

ZONE MAP

N

FIGURE 3

LEGEND

CORDON

SCREEN LINE

ZONE BOUNDARY

ZONE NUMBER

2

HENDERSON

VANCE COUNTY

NORTH CAROLINA

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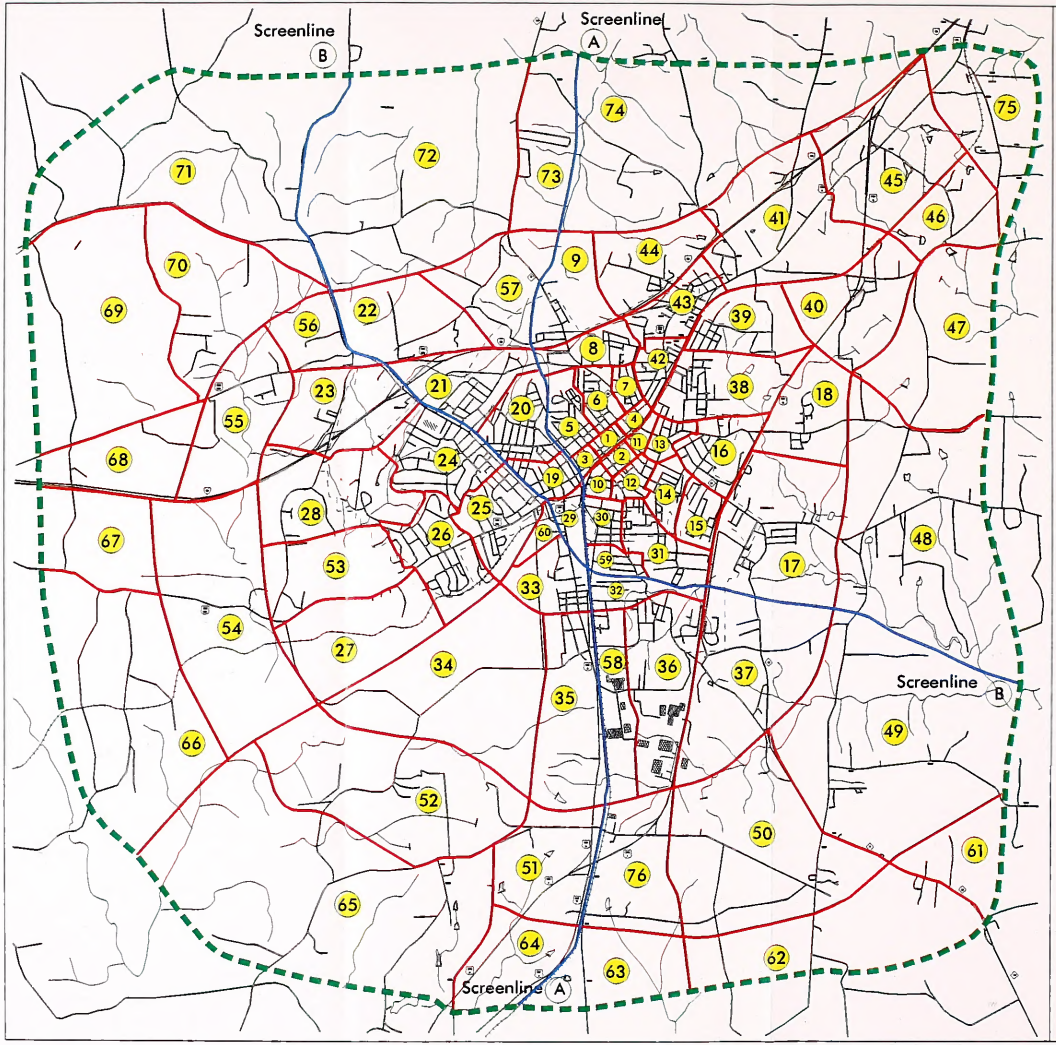

PLANNING AREA

ZONE MAP

N

FIGURE 3

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SCREEN LINE

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HENDERSON

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NORTH CAROLINA

Population Projections for Henderson Planning Area

Travel is directly related to population. The volume of traffic on any given section of roadway is closely related to the size and distribution of the population which it serves. Because of this relationship, one of the basic steps in planning a transportation system is an in-depth population study. The most important population estimate for development of the thoroughfare plan is that of the planning area. Even though government census data is not available for the transportation planning area, data such as number of dwelling units in the planning area and persons per household can be used to estimate the population of the planning area.

The 1993 housing survey for the Henderson Transportation Planning Area gave a final count of 10,061 units (Table A-1). The population for this area was calculated based on overall statistical trends of estimated persons per household. Therefore, the most accurate population count for this planning area multiplies the housing count times the number of persons per household estimated for the Henderson Planning Area.

In 1990 the persons per household ratio in Vance County was 2.75. City of Henderson had a persons per household ratio of 2.60; and Henderson Township 2.65. For the planning area, 2.67 persons per household was calculated based on the 1990 census data. Using a calculated 2.67 persons per dwelling unit for the Henderson Planning Area, a population of 26,862 was estimated for the year 1993.

To project the planning area population to the design year a population growth rate of 0.75% per year was estimated based on the population projections for the Vance County by the State Budget Management Office. This growth rate was then applied to the present transportation planning area population to estimate a populations of 30,500 and 32,866 persons in the years 2010 and 2020 respectively. To convert this figure back to future housing, a 2.52 and 2.40 persons per dwelling unit ratio is used for 2010 and 2020 respectively.

32,866/2.40 = 13,694 Total Dwelling Units in 2020

13,694 - 10,091 (1993 DU's) = 3,633 DU's to be built in the P. A.

3,633 DU's were distributed in the planning area based on housing trends, zoning ordinances and available acreage (Table A-3).

Table 1 shows population trends for Henderson Planning Area, Vance County and Henderson Township. Table 2 shows the distribution of projected housing data.

TABLE 1			
Population Trends for the Planning Area			
Year	Henderson Township	Vance _County	Planning __ Area
1970	20,807	32,691	------
1980	22,300	36,748	23,275
1993	22,247	38,892	26,862
2010	------	43,979	30,500
2020	------	46,049	32,866

TABLE 2			
Housing Type	**%Total**	**# of DU**	**Zones distributed**
Excellent	5%	335	55, 23, 28, 24, 56
Above Average	10%	547	24, 27, 28, 54, 68, 29
Average	40%	1676	27, 38, 44, 50, 51, 53
Below Average	33%	946	37, 49, 50, 48, 47, 46
Poor	12%	129	32, 31, 17, 16,
Total	100%	3633	

POPULATION TRENDS FOR THE HENDERSON PLANNING AREA

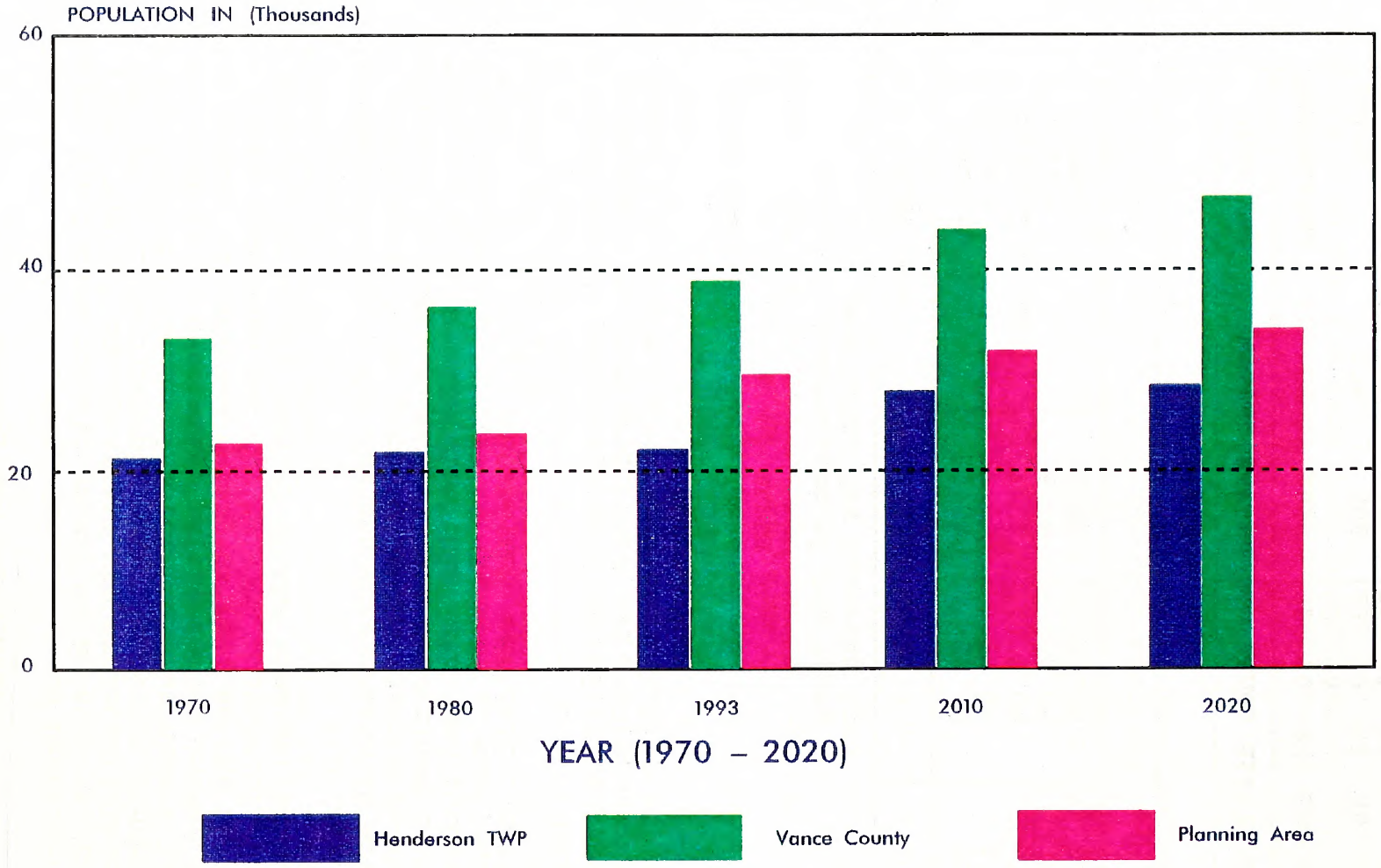


FIGURE 4

Economy and Employment

One of the more important factors to be considered in estimating the future traffic growth of an area is its economic base. The number of employees and the employee's income or purchasing power influences how much population can be supported in the area and the number of motor vehicles that will be locally owned and operated. Generally, as the family income increases so does the number of vehicles owned, as well as the number of vehicle trips generated per day by each household. An accurate projection of the future economy of the area is essential to estimating future travel demand.

Employment figures for the Henderson Planning Area shows that in 1993 there were 15,086 jobs in the planning area (Table A-2). The employment to population ratio was determined to be 0.56. Employment projections made with this ratio and future population estimates indicate a potential 18,404 jobs in the year 2020 (Table A-4) . Similarly, 17,080 jobs were calculated to be available in the year 2010.

A comparison by percentage of five major job types available in the planning area from 1993, 2010 and 2020 shows no significant shift (Table 3). Table 4 shows the distribution of projected employment data.

TABLE 3

Percentages of Job Types Available for Planning Area

Job Type	1993	2010	2020
Industry	50.0%	50.0%	50.0%
Retail	17.0%	17.0%	17.0%
Special Retail	7.0%	7.0%	7.0%
Office	6.0%	6.0%	6.0%
Service	20.0%	20.0%	20.0%

TABLE 4

2020 Emp.	%Total	#of Emp	Zones distributed
Industrial	50%	1659	22, 36, 37, 39, 40, 45 50, 76
Sales	17%	564	23, 29, 51, 56, 69, 27
Special Sales	7%	232	21, 41, 53,
Office	6%	200	29, 48, 69
Service	20%	663	15, 26, 28, 34, 35, 44 46, 51, 54,

Land Use

The generation of traffic on a particular street is very closely related to the utilization of the adjacent land areas. Some types of land uses generate more traffic than do others. For example, a shopping center generates much larger volumes of traffic than do residential areas. The attraction between different land uses varies with the intensity and spatial separation of the uses.

For use in thoroughfare planning, land uses are grouped into four categories: (1) Residential - all land devoted to the housing of people with the exception of hotels and motels; (2) Commercial - all land devoted to retail trade including consumer and business services and office; (3) Industrial - all land devoted to manufacturing, storage, warehousing, and transportation of products; and (4) Public - all land devoted to social, religious, educational, cultural, and political activities. Figures 5 shows the existing planning area's land use.

Anticipated future land use is a logical extension of the present spatial distribution. Determination of where expected growth is to occur within the planning area facilitates the location of proposed thoroughfares. Areas of anticipated development and growth for Henderson are:

Residential

The majority of residential acreage is single family, followed by two and multi-family occupancy. the majority of recent residential growth has occurred toward the west where public utilities, topography and soil types are suitable for residential development. The location with the most potential for residential development is on the west and north side of the city (See Figure 6).

Commercial/Retail

The majority of the commercial development in Henderson is in the following areas: The central business district along Garnett Street, along US 1 Business (Raleigh Road), along I-85 and Dabney Drive and along northern section of the US 1 Bypass.

Industrial

Industrial development exist mostly in the south and east of the Henderson Planning Area, however some industrial development exists along I-85, Dabney Drive, US 1 Business and US 1 Bypass.

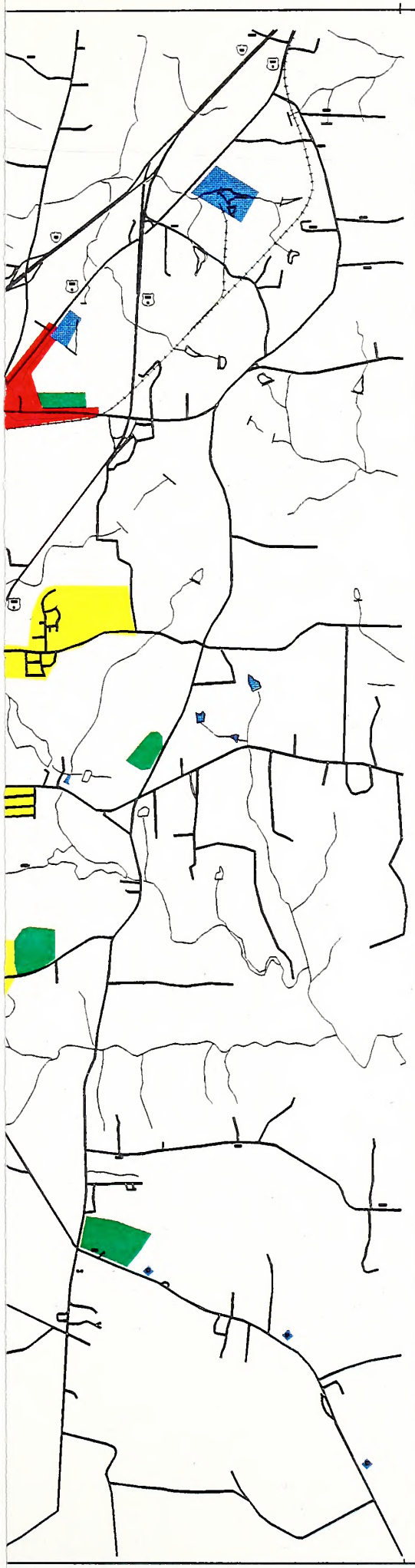
Public

Public areas are evenly located throughout the Henderson Planning Area. Public park facilities available for recreational use are Eaton-Johnson, Kings Daughter, North Henderson, Owen Davis,

Pinkston, Rollins and Jaycee, South Henderson and Fox's Pond (See Figure 5).

Land use projections for the design year (2020) were made by the City of Henderson's Planning and Community Development Department. The same trends were assumed to continue for the design year (2020).

Figure 6 shows the anticipated design year (2020) land use for the planning area.



1994 LAND USE

N

FIGURE 5

LEGEND

RESIDENTIAL

COMMERCIAL

INDUSTRY

PUBLIC

HENDERSON

VANCE COUNTY

NORTH CAROLINA

Pinkston, Rollins and Jaycee, South Henderson and Fox's Pond (See Figure 5).

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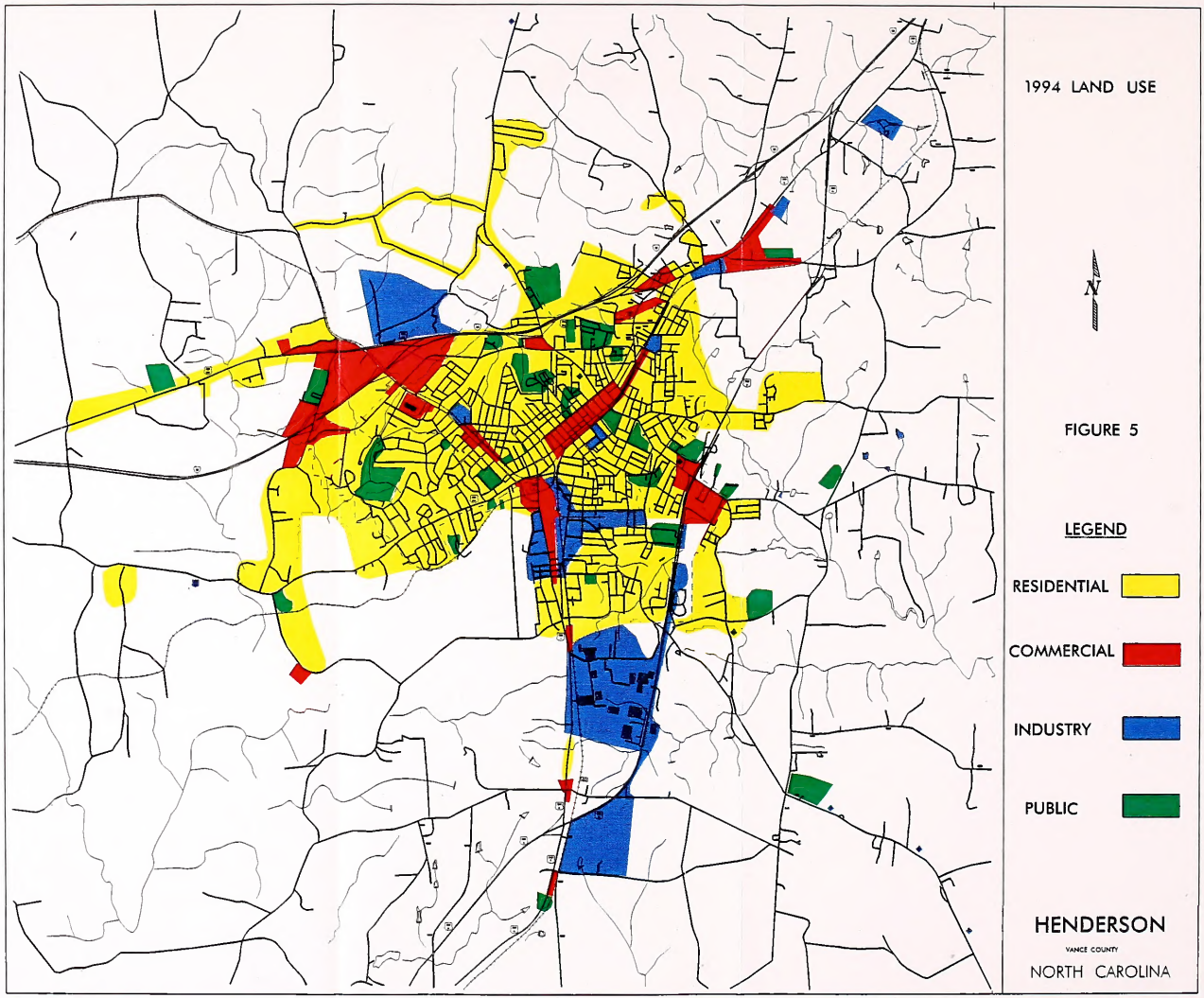
1994 LAND USE
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FIGURE 5
LEGEND
RESIDENTIAL
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VANCE COUNTY
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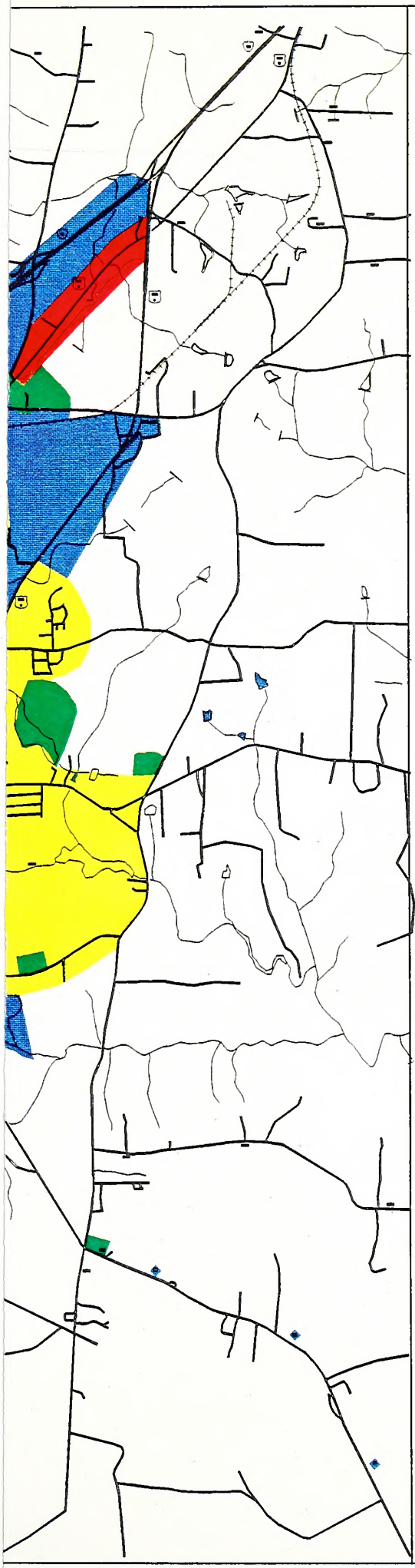

2020 LAND USE

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FIGURE 6

LEGEND

RESIDENTIAL

COMMERCIAL

INDUSTRY

PUBLIC

HENDERSON

VANCE COUNTY

NORTH CAROLINA

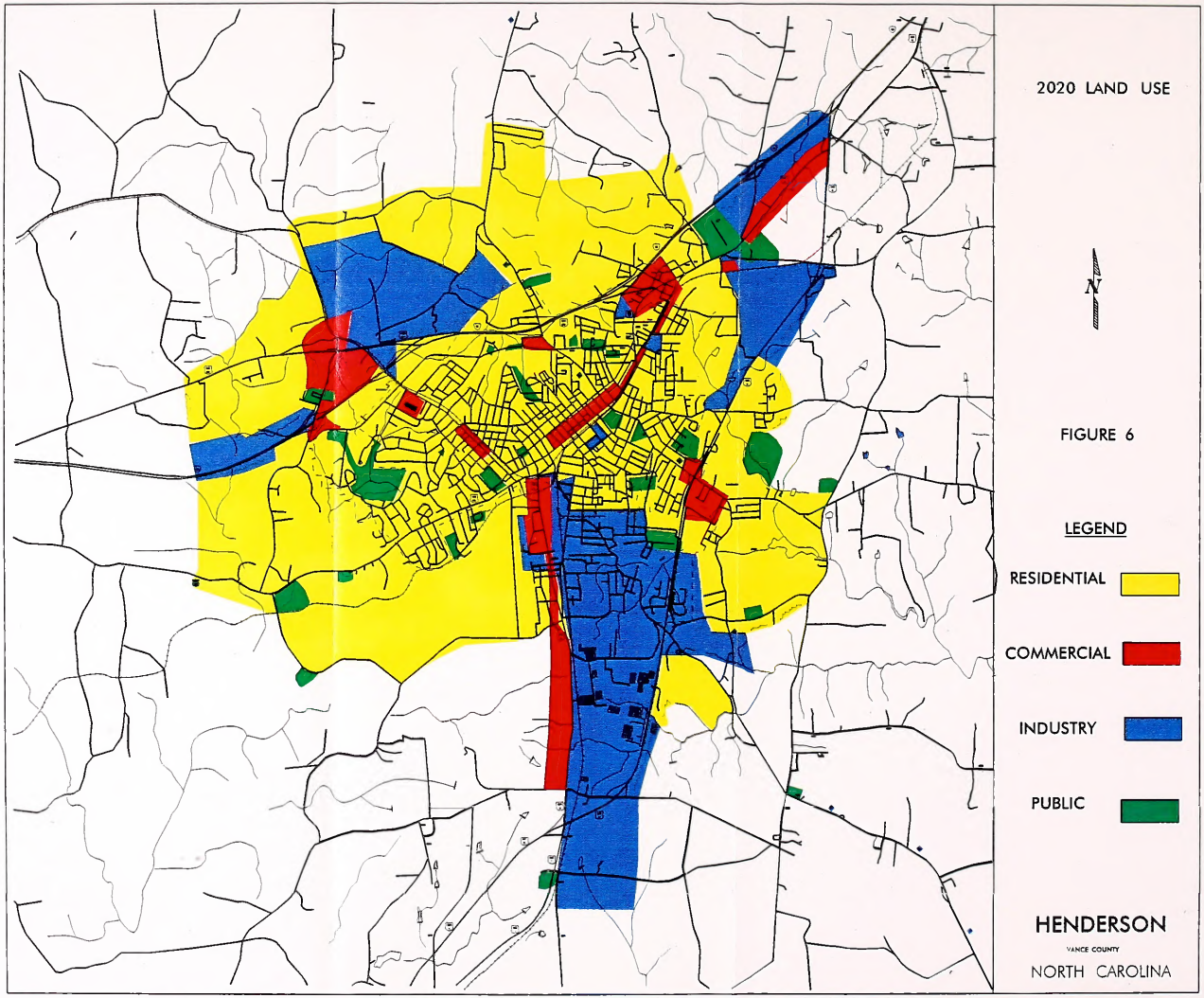
2020 LAND USE
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FIGURE 6
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IV. TRAVEL FORECAST MODELS

While traffic volume counts on existing streets are useful in evaluating the ability of the current system to meet travel demands, they reveal little as to the actual travel desires (origins and destinations) of the motorist. For thoroughfare planning purposes, a comprehensive knowledge of the origins and destinations of existing traffic and estimated future traffic is essential.

The type, intensity, and location of the population and employment within an area largely determine the travel patterns. The method used to predict future travel involves the development of mathematical models relating population and employment to travel. Models are developed to (1) estimate trips produced (origins) and trips attracted (destinations) by traffic zones and (2) to estimate travel patterns between zones. Separate models are developed for the three basic types of trips: internal, internal-external, and through. **Internal trips** are defined as those trips which have both origin and destination inside the planning area. An **internal-external trip** is a trip which has one end inside the planning area and the other outside. **Through trips** are defined as those trips which travel through the area and have both origin and destination outside the study area.

The travel forecast models for the Henderson area were developed on the basis of travel, employment and population data obtained for the base year 1994. The validity of the models was tested by comparing the traffic volumes computed by the models to traffic volume counts taken on the existing street system.

After travel forecast models have been calibrated so that they adequately duplicate travel, design year travel estimates are produced through the input of design year data on population and employment. The trip distribution models are sensitive to changes in the street system and variation will occur in the travel patterns as alternative future street plans are tested. A more detailed documentation of the travel forecast models is given in Appendix A. Table 5 gives a summary of travel data trends for the area.

TABLE 5

TRAVEL DATA SUMMARY		
Type	1993	2020
Average Daily Trips per DU	7.19	7.38
Internal Trips	67,876	94,644
Home Based Work	16,290	22,715
Other Home Based	36,653	51,108
Non-Home Based, internal	16,290	22,715
NHB secondary	16,400	32,760
Internal <-> External	51,138	90,060
Through Trips	55,032	137,362

Average Daily Trip/DU = the number of internal personal auto trips divided by total DU

V. ANALYSIS OF THE EXISTING STREET SYSTEM

This chapter presents an analysis of the ability of the existing street system to serve the area's travel desires. Emphasis is placed not only on detecting the deficiencies, but on understanding their cause. Travel deficiencies may be localized and the result of substandard highway design, inadequate pavement width, or intersection controls. Alternately, the underlying problem may be caused by a system deficiency such as a need for a bypass, loop facility, construction of missing links, or additional radials.

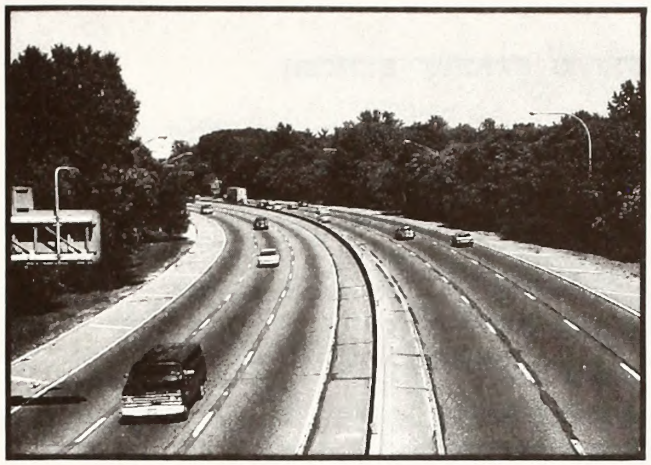
Existing Travel Patterns

A relatively good indication of the adequacy of the existing major street system is a comparison of the traffic volumes with the ability of the street to move traffic, its **capacity.** In an urban area, a street's ability to move traffic is generally controlled by the spacing of major intersections, the width of the pavement, and the traffic control devices utilized. Thus the ability of a street to move traffic can be increased to some degree by restricting parking and turning movements, using proper sign and signal devices, and by application of other traffic engineering techniques. According to 1985 Highway Capacity Manual, capacity is defined as the maximum number of vehicles which has a reasonable expectation of passing over a given section of a roadway in one direction, or in both directions, during a given time period under prevailing roadway and traffic conditions. The relationship of traffic volumes to the capacity of the roadway will determine the level of service being provided. Six levels of service (LOS) are used (Figure 4) to identify the conditions existing under various speed and volume conditions on any Highway or street. The six levels of services are:

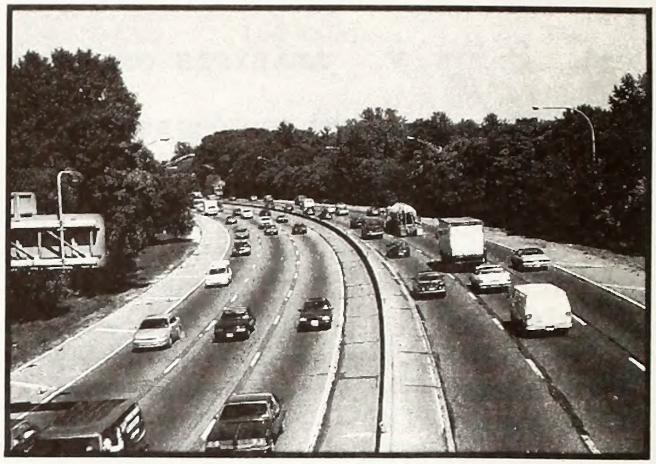
1. Level-of-service A represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.

2. Level-of-service B is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from level-of-service A.

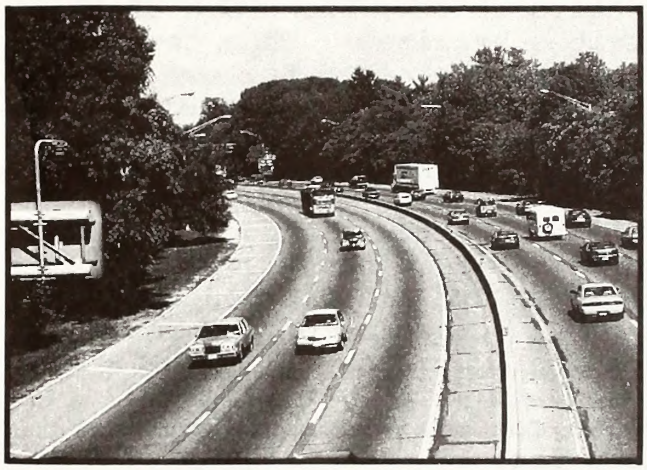
Source: 1994 Highway Capacity Manual



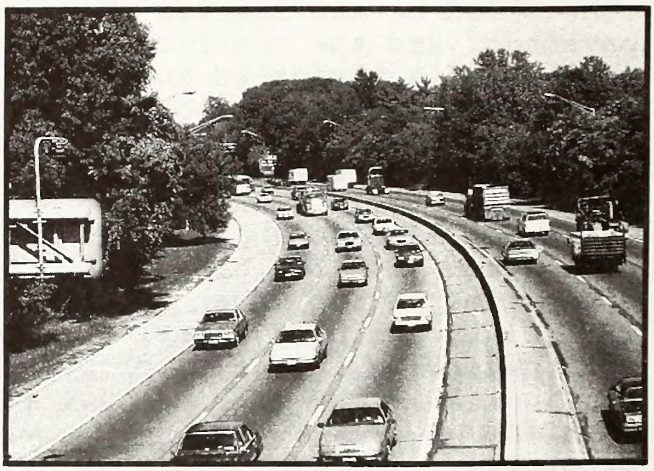
LOS A.



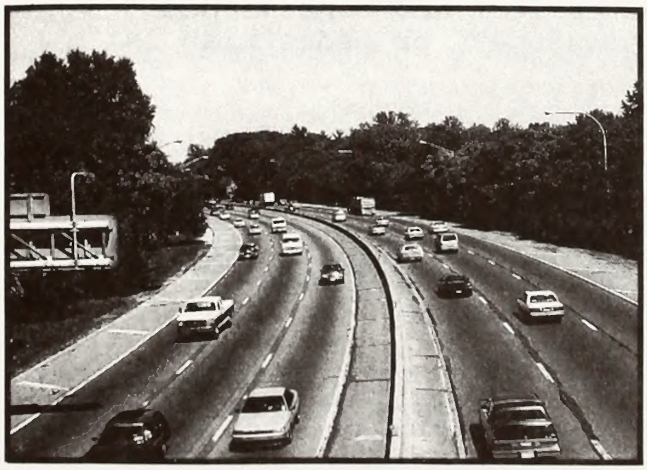
LOS D.



LOS B.



LOS E.



LOS C.

LOS F.

FIGURE 7

LEVELS OF SERVICE

3. Level-of-service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic steam will cause breakdowns. Maneuvering within the traffic stream requires substantial caution on the part of the user. The general level of comfort and convenience declines noticeably at this level.

4. Level-of-service D represents high-density, but stable flow. Speed and freedom to maneuver are severely restricted. The driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

5. Level-of-service E represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Maneuver within the traffic stream is extremely difficult, an it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers.

6. Level-of-service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues from behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. In many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. It is the point at which arrival flow exceeds discharge flow which causes the queue to form. Level-of-service F is an appropriate designation for such points.

Capacity Deficiencies

The purpose of calculating capacities of the major links of the street network was to know how well the network could serve existing and design year (2020) traffic. In 1994 capacity analysis reveals that the following sections of the roadway system within the Henderson Planning Area are over capacity (See Figure 8):

1) NC 39 (Andrews Avenue) from Bullock Street to Chestnut Street;

2) Garnett Street from NC 39 (Andrews Avenue) to US 1/US 158 at Warrenton Road; and

3) Dabney Drive from Oxford Road to Roanoake Avenue.

The following sections are approaching capacity:

1) US 1 Business from SR 1115 (Bear Pond Road) to Garnett Street;

2) Garnett Street from NC 39 (Andrews Avenue) to Dabney Drive;

3) Dabney Drive from Roanoke Street to I-85;

4) NC 39 (Andrews Avenue) from Chestnut Street to I-85;

5) NC 39 (Andrews Avenue) from Bullock Street to SR 1533 (Vicksboro Road); and

6) Beckford Drive from NC 39 (Andrews Avenue) to Roanoke Avenue.

For design year capacity analysis, the 2020 travel desires were generated from the calibrated model and were assigned to the existing major street system. Deficient corridors created by the 2020 traffic demand assigned to the existing network were then observed (See Figure 9).

System Deficiencies

System deficiencies are a measure of the extent to which the existing system lacks continuous radials, loops, crosstowns, and bypasses. The following system deficiencies were identified for the Henderson Planning Area.

1) Lack of a complete loop facility to facilitate through trip movements and lateral movements in the outlying areas;

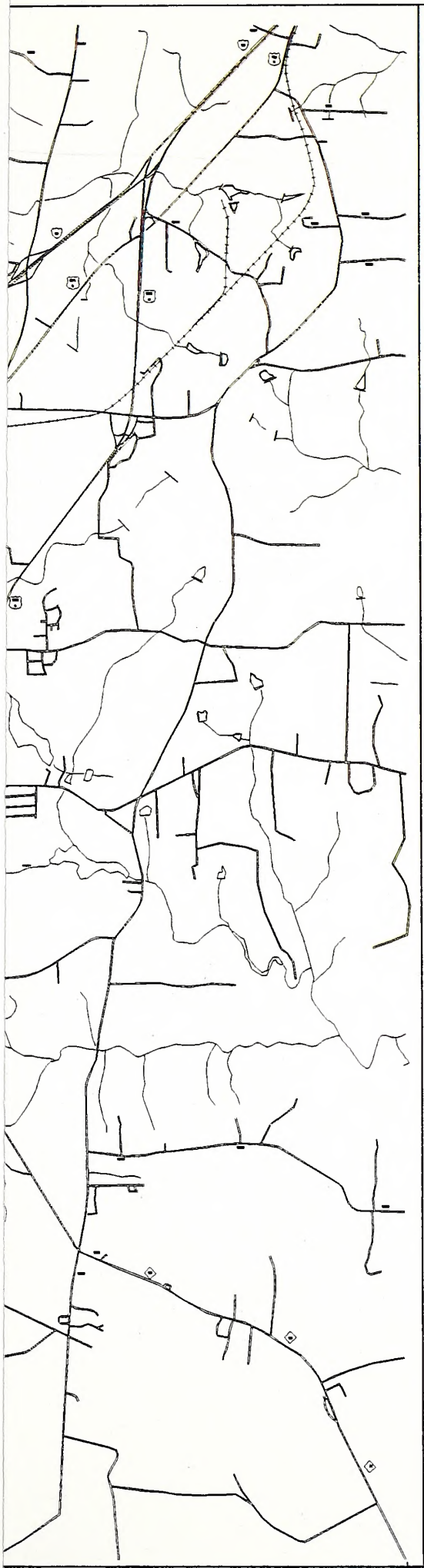
2) Lack of a good crosstown system;

3) Poorly aligned and narrow radial streets

4) inaccessibility and deficiencies mainly caused by the railroads

Special Corridors

National Truck Network routes, as designated by the U.S. Secretary of Transportation for STAA (Surface Transportation Assistance Act) vehicles, include US 1 and I-85.



1994 VOLUMES vs. CAPACITY

N

FIGURE 8

LEGEND

NEAR CAPACITY

OVER CAPACITY

HENDERSON

VANCE COUNTY

NORTH CAROLINA

1) NC 39 (Andrews Avenue) from Bullock Street to Chestnut Street;

2) Garnett Street from NC 39 (Andrews Avenue) to US 1/US 158 at Warrenton Road; and

3) Dabney Drive from Oxford Road to Roanoake Avenue.

The following sections are approaching capacity:

1) US 1 Business from SR 1115 (Bear Pond Road) to Garnett Street;

2) Garnett Street from NC 39 (Andrews Avenue) to Dabney Drive;

3) Dabney Drive from Roanoke Street to I-85;

4) NC 39 (Andrews Avenue) from Chestnut Street to I-85;

5) NC 39 (Andrews Avenue) from Bullock Street to SR 1533 (Vicksboro Road); and

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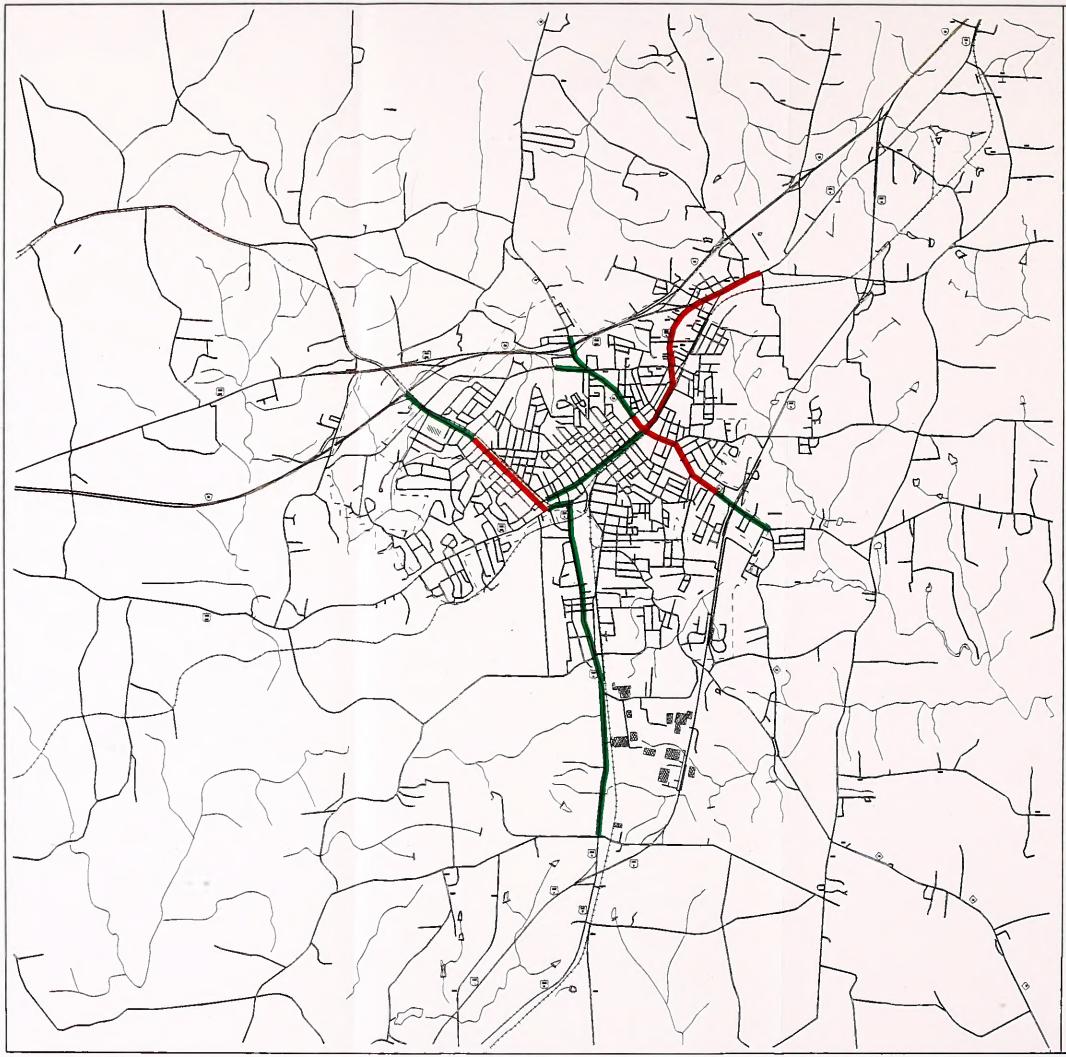


1994 VOLUMES

vs. CAPACITY

N

FIGURE 8

LEGEND

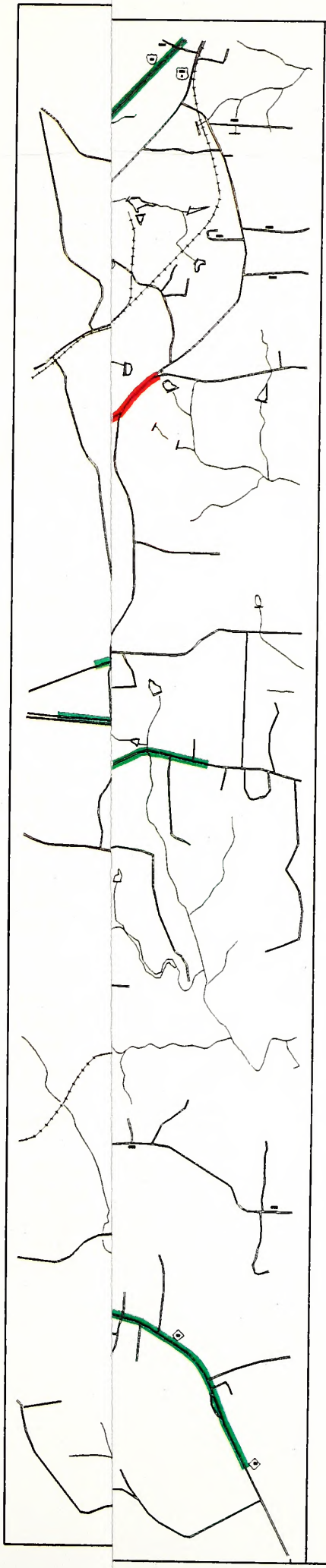
NEAR CAPACITY

OVER CAPACITY

HENDERSON

VANCE COUNTY

NORTH CAROLINA



2020 VOLUMES

vs. CAPACITY

N

FIGURE 9

LEGEND

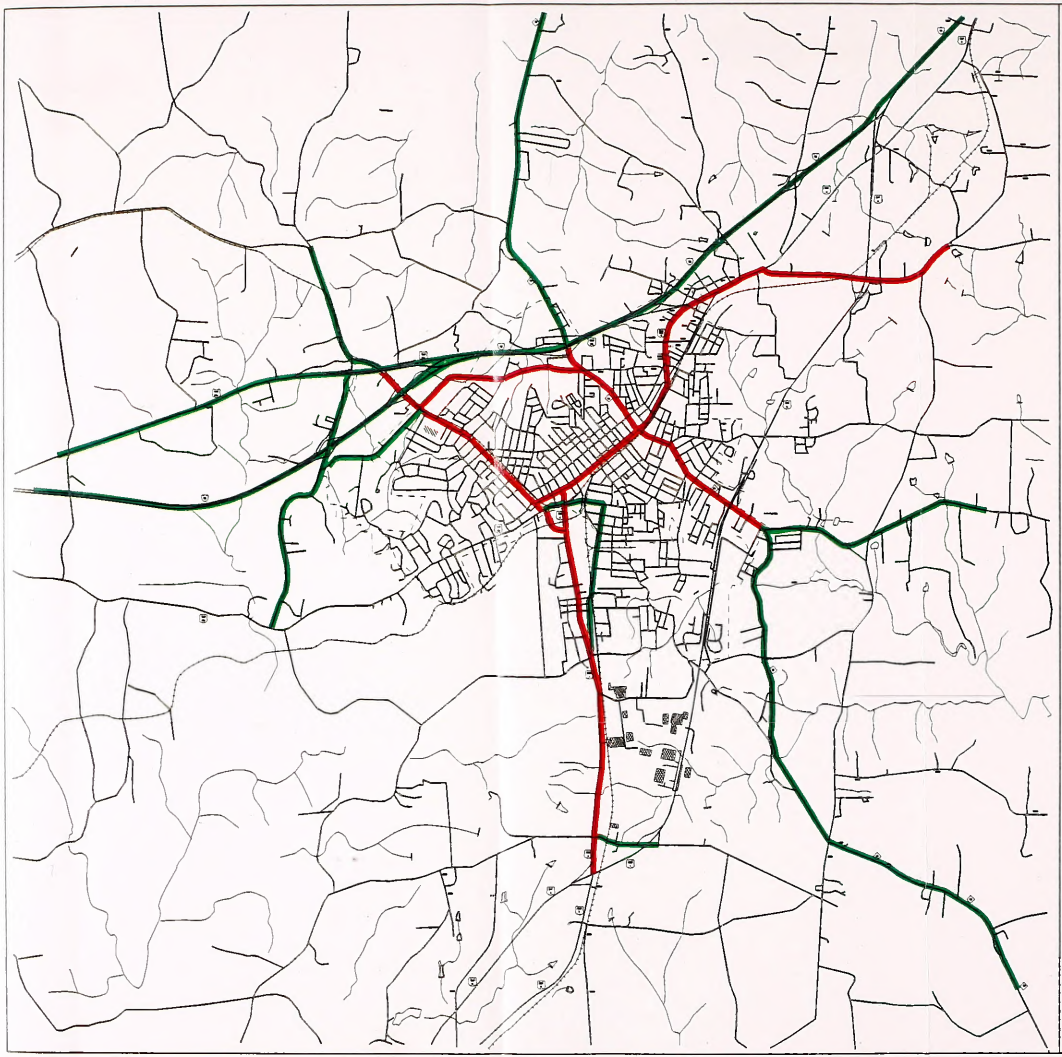
NEAR CAPACITY

OVER CAPACITY

HENDERSON

VANCE COUNTY

NORTH CAROLINA



2020 VOLUMES

vs. CAPACITY

N

FIGURE 9

LEGEND

NEAR CAPACITY

OVER CAPACITY

HENDERSON

VANCE COUNTY

NORTH CAROLINA

Goals and Objectives

Each area has its own priorities and concerns relating to the transportation system, and related topics. In order to determine the items of importance to the planning area, a "Goals and Objectives" survey was conducted in 1990. The survey included questions about topics such as new roads, improvement to existing roads, sidewalks, traffic signals and truck routes. A space was provided for comments at the end of the survey.

Henderson officials helped in distributing the survey forms to the planning area citizens and the local newspapers encouraged the citizens to express their opinion by responding to the survey. Twelve (12) responses were received. Appendix B includes a copy of the survey and the comments received.

Traffic Accidents

High Accident Location - Traffic accident records are of assistance in defining problem areas and often pinpoint a deficiency such as poor design, inadequate signing, ineffective parking, or poor sight distance. Accident patterns developed from analysis of accident data can lead to remedial action reducing the number of accidents.

Both the severity index and number of accidents should be considered when investigating accident data. The severity of every accident is measured with a series of weighting factors developed by NCDOT's Division of Highways. In terms of these factors, a fatal or incapacitating accident (Type F and A) is 64 times more severe than one involving only property damage, and an accident resulting in an injury (Type B and C) is 19.1 times more severe than one with only property damage.

Table 6 lists high accident intersections. The "Total" column indicates the total number of accidents reported within two hundred (200) feet of the intersection during the specified time period. The severity index is calculated by the Traffic Engineering Branch using the following formula:

Severity Index = {64(F+A)+19.1(B+C)+PDO} / Total Accidents

F = Fatal Accidents
A = Type A Accidents (Incapacitating)
B = Type B Accidents (Serious Injury)
C = Type C Accidents (Minor Injury)
PDO = Property Damage Only

TABLE 6

ACCIDENT SUMMARY (6/01/90 TO 5/31/93)

LOCATION	TOTAL	SEVERITY INDEX
Beckford & Dabney	37	8.32
Graham & Dabney	26	6.57
Coble & Dabney	24	8.15
Andrews & Beckford	23	11.61
Andrews & Chestnut	21	5.31
Cooper & Dabney	20	7.77
Garnett & Montgomery	19	11.44
Andrews & Garnett	18	8.52
Dabney & Lynn	17	5.26
Dabney & Parham	16	5.53
Andrews & Bullock	16	9.46
I-85 & US 1	15	11.23
Dabney & Oxford	15	3.41
Andrews & Pinkston	15	8.24
Dabney & Deer Crossing	14	2.29
US 1 & Andrews	14	18.43
I-85 & Dabney	14	4.88
SR 1518 & SR 1519	14	25.46
Andrews & Rowland	14	11.96
Andrews & Clark	14	7.46
Raleigh & Dorsey	14	3.59
I-85 & SR 1128	12	9.27
US 1 & US 1 Business	12	10.78
Dabney & Roanoke	12	4.02
Andrews & Liberty	12	10.78
Dabney & Bane	12	13.07
Garnett & Rockspring	12	9.27
William & Montgomery	12	10.05
Dabney & Oakdale	12	4.02
US 158 & SR 1128	11	17.39
Andrews & Jane	11	10.02
Andrews & Shank	11	12.45
William & Winder	11	17.39
I-85 & US 158	10	20.84
SR 1148 & SR 1538	10	16.35
I-85 & Andrews	10	1.00
Garnett & Bell	10	6.43
Garnett & Old Norlina	10	10.05
Breckenridge & Walnut	8	25.80
NC 39 & SR 1329	8	29.15
US 1 Business & SR 1139	7	20.34
Breckenridge & Chestnut	6	20.55
Pinkston & Water	6	31.05
Beckford & Chestnut	6	23.57
Raleigh & Miriam	5	24.46
Beckford & Parrish Mill	5	20.84
US 1 Business & SR 1317	5	20.84
US 1 Business & SR 1101	5	28.08

Lack of a complete loop facility and crosstown roads cause the heavy traffic volumes on Dabney Drive, Andrews Avenue and Beckford Drive which contributes to heavy accidents along these Roads. The proposed Western outer loop which is programed in TIP should contribute to much safer driving conditions in the planning area.

VI. RECOMMENDED 1994 THOROUGHFARE PLAN

A thoroughfare plan study uncovers the need for new facilities, plus identifies existing and future deficiencies in the transportation system. The thoroughfare plan is a representation of the existing highway system by functional use, e.g., major thoroughfares, minor thoroughfares plus any new facilities which are needed. The planning methodology enables identification of deficiencies in the existing system, allowing the compilation of a list of needed improvements.

This chapter presents an analysis and makes recommendations based on the ability of the existing street system to serve the present and future travel desires as the area continues to grow. The usefulness of transportation planning is in the analysis of different highway configurations for their efficiency in serving the area. The recommended plan sets forth a system of thoroughfares to serve the anticipated traffic and land development needs for the Planning Area. The need to eliminate existing and projected system deficiencies which cause traffic congestion and safety hazard is the primary objective of the plan. The Western Outer Loop, the extension of the Pinkston Street, widening of Beckford Drive, extension of Main Street to Pinkston Street Extension and to proposed service road along US 1 Bypass (East Avenue Extension), and Widening of NC 39 (Andrews Avenue) in the Henderson Planning Area are significant steps in overcoming projected capacity and system deficiencies.

The recommendations for the Henderson Thoroughfare Plan are based on the results of a traffic forecast model that uses data on traffic counts, population, housing, employment, and vehicle ownership to simulate travel (See Chapter IV). With this model each major street and highway in the Planning Area is analyzed to determine its ability to serve existing and future traffic demands. In the development of this thoroughfare plan the 1981 Henderson Thoroughfare Plan was consulted. Some of the proposals from the previous thoroughfare plan were found inadequate for current conditions.

Thoroughfare Plan Recommendations

The process of developing, testing and evaluating alternate plans involved a number of considerations. These included Henderson area goals and objectives, identified deficiencies (See Chapter V), environmental impacts, existing and anticipated land development, and travel services. Aerial photography, topographic mapping, wetland inventory mapping, field investigation and open discussion with local staff, officials, Chamber of Commerce and interested local citizens provided additional basis for identifying and evaluating the feasibility of the alternative alignments and their potential impacts.

A recommended Plan was developed and on June 13, 1994, a public hearing was held. Henderson City Councils endorsed the

Henderson Thoroughfare Plan on October 10, 1994. Figure 10 shows the mutually adopted 1994 Henderson Thoroughfare Plan, map dated October 6, 1994. The major new facilities are as follows:

1) Western Outer Loop from SR 1115 (Bear Pond Road) to SR 1128 (Ruin Creek Road). The Section from SR 1128 to SR 1101 (Belmont Drive) is currently programmed in TIP (U-2527).

2) Pinkston Street Extension from Water Street to SR 1317 (Spring Valley Road).

3) Extension of SR 1208 (East Avenue) to John Deere Road to function as a service road for US 1 Bypass.

4) Extension of Main Street to connect to Pinkston Street Extension and East Avenue Extension.

5) Extension of Warehouse Road to Fuller Street.

6) Fuller Street Extension to McArthur Street.

7) Welcome Avenue Extension to Old Epsom Road.

8) Thorpe Street Extension to US 1 Business.

9) Merriman Street Extension to Beckford Drive

10) Lattiemore Road Extension to Western Loop

11) Belle Street Extension to Chavasse Avenue

12) Alexander Avenue Extension to Jane Avenue

The new facilities provide for continuity of travel, corridor spacing, and/or a more direct travel path. The following describes the plan in terms of its functional parts as previously discussed in Chapter II of this report. For additional supporting data on these recommendations see Appendix D.

Bypass Facility

A bypass is designed to carry traffic through or around the urban area, thus providing relief to the local street system by removing traffic which has no desire to be in the City. Occasionally a low traffic volume bypass can be designed to function as a portion of a planning area loop. The following are the existing and recommended bypass facilities for the Planning Area:

1) I-85 serves mainly interstate and east-west through travel north of Henderson. Projected design year traffic volumes for I-85 will approach capacity. I-914, I-2726, I-2810 and I-2811 are the current Transportation Improvement Program (TIP) projects for I-85 safety improvement, pavement

rehabilitation and bridge rehabilitation in Vance County.

2) US 1 Bypass from SR 1114 (Edwards Road) south of the Henderson Planning Area to I-85 north of the Planning Area. US 1 Bypass provides for north-south through traffic along the east side of Henderson. The existing interchange at I-85 does not accommodate for south-bound I-85 traffic from US 1 Bypass. Similarly there is no ramp for north-bound traffic on I-85 to travel south on US 1 Bypass. This interchange needs to be redesigned so that it would accommodate all turning movements.

3) US 158 Bypass carries through traffic around north side of Henderson.

Loop System:

A loop facility is intended to handle traffic between outlying areas and act as a connector between radials. The Henderson Planning Area currently does not have such a system. The proposed Western Outer Loop will function as a loop facility for north and western sections of the Planning Area where the future growth is anticipated to be much greater than the rest of the Planning Area.

1) Henderson Western Outer Loop from SR 1115 (Bear Pond Road) to SR 1128 (Ruin Creek Road). The Section from SR 1128 to SR 1101 (Belmont Drive) is currently programed in TIP (U-2527). The proposed Western Loop will provide for circumferential travel movements in the western sections of the Henderson Planning Area as well as providing for the expected growth and development of the Planning Area and will relieve the congestion created by the through traffic on existing Dabney Drive and US 1 Business. The proposed Western Outer Loop is recommended to be 2-lane facility (28 feet in width, with 12-foot shoulders) on multi-lane Right of Way.

   Western Outer Loop, SR 1115 (Bear Pond Road/North Lynnbank Road), US 1 Bypass, I-85, and SR 1128 (Ruin Creek Road) will comprise the Henderson Outer Loop.

2) Inner Loop: Beckford Drive, Graham Avenue, Wiggins Street, Main Street, extension of Main Street to Pinkston Street Extension, Pinkston Street Extension, McAurthur Street, Fuller Street, Welcome Avenue, Welcome Avenue Extension, Belmont Drive, County Home Road and portion of the Western Outer Loop will comprise the Henderson inner loop.

Radial Thoroughfares:

The radial thoroughfare system will provide for traffic movements between points in outlying areas and the central area. The following existing facilities comprise the radial system:

1) Andrews Avenue (NC 39) serves as a major radial and provides the most direct access to US 1 Bypass and I-85 from the Central Business District (CBD). It also carries NC 39 traffic from southeast Henderson to north Henderson. It is recommended that the Andrews Avenue be widened to a 4-lane facility from Bullock Street to Chestnut Street (the existing 2-lane section through the City of Henderson).

2) Chavasse Avenue (SR 1228), Flint Street, Flint Street Extension to Country Home Road and Oxford Road, will provide for a radial facility to serve the central east-west traffic.

3) Dabney Drive (SR 1162) is a major radial, serving northwest Henderson to CBD. Dabney Drive is a vital connector between Raleigh Road (US 1 Business), Beckford Drive (SR 1165), I-85 and US 158 Bypass.

4) Old Epsom Road (SR 1148)/Vanco Mill Road (SR 1148) are major radials connecting southeast Henderson to the central Henderson.

5) Oxford Road (US 158 Business) is a major radial serving western and central residential traffic. It also serves US 158 Business travel.

6) Raleigh Road (US 1 Business) is one of the major radials for the Henderson Planning Area. It is recommended that the US 1 Business be widened from the US 1 Bypass to SR 1262 (Dabney Drive) to 5-lanes with curb and gutter (TIP R-2503).

7) Vicksboro Road (SR 1533) is a major radial serving areas east of Henderson and connects to NC 39 for access to US 1 Bypass, CBD and I-85.

8) Water Street/Newton Dairy Road (SR 1518) are major radials serving areas northeast of Henderson to NC 39 and CBD.

Crosstown Streets

The crosstown streets provide for travel across and through the central area. The following existing streets comprise the crosstown streets in the Planning Area:

1) Chestnut Street (SR 1226) is a good example of a crosstown facility.

2) Garnett Street is a major crosstown facility. Garnett Street is also used by US 1 Business and US 158 Business traffic.

3) Orange Street, Cross Street, Cross Street Extension to Merriman Street and Merriman Street Extension to Beckford Drive will comprise a minor crosstown system.

4) Young Avenue and Stanley Street are minor crosstown roads.

Other Major Thoroughfares:

1) Abbott Road (SR 1547)

2) Brodie Road (SR 1245)

3) County Home Road/Belmont Drive (SR 1101)

4) Dabney Road (SR 1304)

5) Edwards Road (SR 1114)

6) Hicks Road (SR 1303)

7) Kelly Road (SR 1326)

8) Main Street (SR 1554) is recommended to be extended to connect to Pinkston Street Extension and East Avenue Extension.

9) Newton Dairy Road (SR 1518)

10) Nicholas Street (SR 1143)

11) North Lynnbank Road/Bear Pond Road (SR 1115)

12) Peter Gill Road (SR 1548)

13) Rock Mill Road/Gillburg Road/Carey Chappel Road (SR 1519)

14) Ruin Creek Road (SR 1128)

15) Saint Andrews Church Road (SR 1309)

16) Satterwhite Point Road (SR 1319)

17) South Lake Lodge Road (SR 1113)

18) Spring Valley Lake Road (SR 1318)

19) Spring Valley Road (SR 1317)

20) Thorpe Street (SR 1161) is recommended to be extended across Brodie Street (SR 1245) and connect to Miriam Street. The dog-leg at the intersection of Miriam Street and Wilkins Street (SR 1216) is recommended to be corrected.

21) Vance Academy Road (SR 1120)

22) Warrenton Road (SR 1001)

23) Welcome Avenue (SR 1138) is recommended to be extended to connect to Fuller Street (SR 1141) and Old Epsom Road (SR 1148).

24) Wilkins Street (SR 1213) and Fields Avenue (SR 1244) and Fields Avenue Extension to Old Epsom Road (SR 1148)/ Vanco Mill Road (SR 1148).

Other Minor Thoroughfares

Minor thoroughfares carry out a collector-distributor function and perform a greater land service function than do the major thoroughfares. These streets are as follows:

1) Alexander Avenue (SR 1160) is recommended to extend to Jane Avenue (SR 1221)

2) Belle Street is recommended to extend to Chavasse Avenue.

3) Corbitt Road

4) Cypress Drive

5) Jane Avenue (SR 1221)

6) J.P. Taylor Road (SR 1139)

7) King Street (SR 1138) is recommended to extend to Field Avenue Extension.

8) Latimore Road is recommended to be extended to connect to the Henderson Western Outer Loop

9) Orange Street/Cross Street/Merriman Street.

10) Parham Street

11) Poplar Street/Montgomery Street.

12) Roanoke Avenue (SR 1163)

13) Stanley Street

14) Summitt Road

15) Warehouse Road (SR 1216)

16) Young Avenue

There are some two-lane roads in the Henderson area which have paved widths less than 22 feet. This is the minimum desirable cross-section. A desirable lane width of 12 feet yields a 24-foot paved roadway. Narrow roadways increase the likelihood of accidents between vehicles traveling in the opposite direction. This becomes more critical as traffic increases to 5,000 or 6,000 vpd as there is increased incidence of meeting oncoming traffic.

Cross-sections - Each facility on the Thoroughfare Plan is

discussed earlier in this chapter. A summary of the recommended cross-sections for each facility is in Appendix D. The minimum desirable cross-section is twenty-four feet with paved shoulders or curb and gutter.

System Improvements - Often system improvements can provide additional capacity or improved traffic conditions with a minimum of capitol outlay. Recommended system improvements include:

1) Consideration of an aggressive carpool/vanpool program and collection of vehicle occupancy count data. The capacity of a facility to carry people can be increased by increasing the occupancy of the existing vehicles.

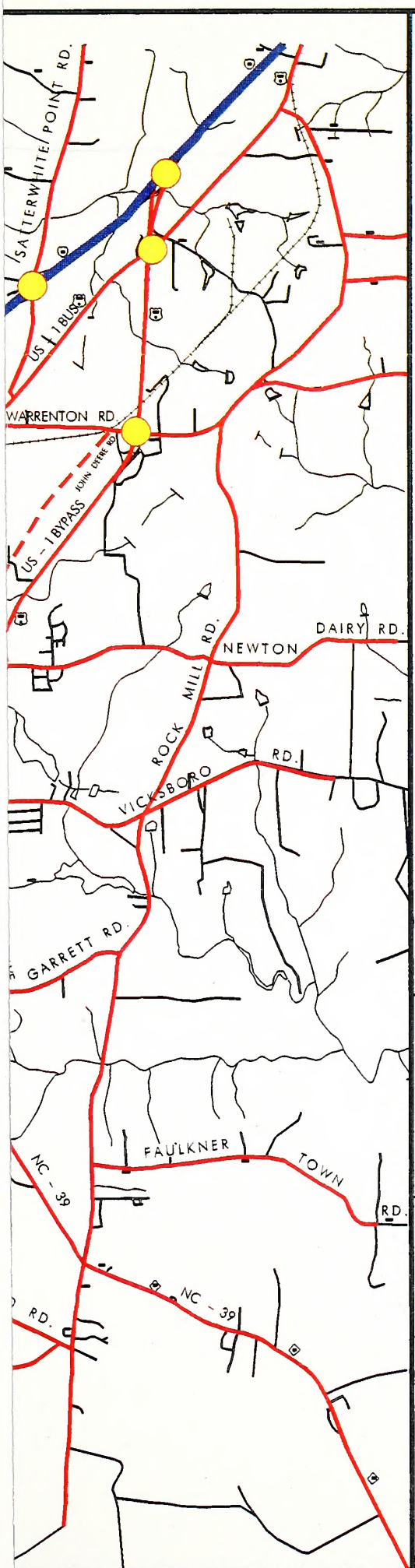
2) Encouraging local businesses to stagger work hours will decrease traffic volumes in the peak travel hours.

3) A continuing program to assure proper timing and phasing of all traffic signals will reduce traffic delays. Proper signal progression can have significant positive impact on a corridor; this is especially true with US 1 Business, US 158 Bypass, US 158 Business, Dabney Drive, Andrews Avenue and Garnett Street. The Traffic Engineering Branch of the North Carolina Department of Transportation is implementing some new high impact congestion management strategies and techniques. As for the Planning Area, implementation of a fully actuated, closed loop signal system controlling the existing major intersections located along US 158, US 1 Business, Dabney Drive, Andrews Avenue, Beckford Drive, Garnett Street and Chestnut Street is recommended.

4) Protection of access control is one of the areas where a significant contribution can be made. The limiting of driveway permits along US 1 Bypass, US 1 Business, US 158 Bypass, US 158 Business and the construction of a partial controlled access Western Outer Loop are good places to begin.

5) Offset intersections contribute to congestion and by correcting the offset intersections, capacity and safety will be improved.

6) A single unprotected left turning car can take the capacity equivalent of five through vehicles. The cross-section recommendations presume that the left turns at key intersections are provided.



HENDERSON
THOROUGHFARE
PLAN

LEGEND

	EXISTING	PROPOSED
FREEWAY		
MAJOR THOROUGHFARE		
MINOR THOROUGHFARE		
INTERCHANGE		
GRADE SEPARATION		

N

S

ADOPTED BY:

CITY OF HENDERSON: OCTOBER 10, 1994

RECOMMENDED BY STATEWIDE PLANNING BRANCH: OCTOBER 17, 1994

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION: NOVEMBER 4, 1994

FIGURE 10

HENDERSON

VANCE COUNTY

NORTH CAROLINA

PREPARED BY THE
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS STATEWIDE PLANNING BRANCH
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

OCTOBER 6, 1994

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System Improvements - Often system improvements can provide additional capacity or improved traffic conditions with a minimum of capitol outlay. Recommended system improvements include:

1) Consideration of an aggressive carpool/vanpool program and collection of vehicle occupancy count data. The capacity of a facility to carry people can be increased by increasing the occupancy of the existing vehicles.

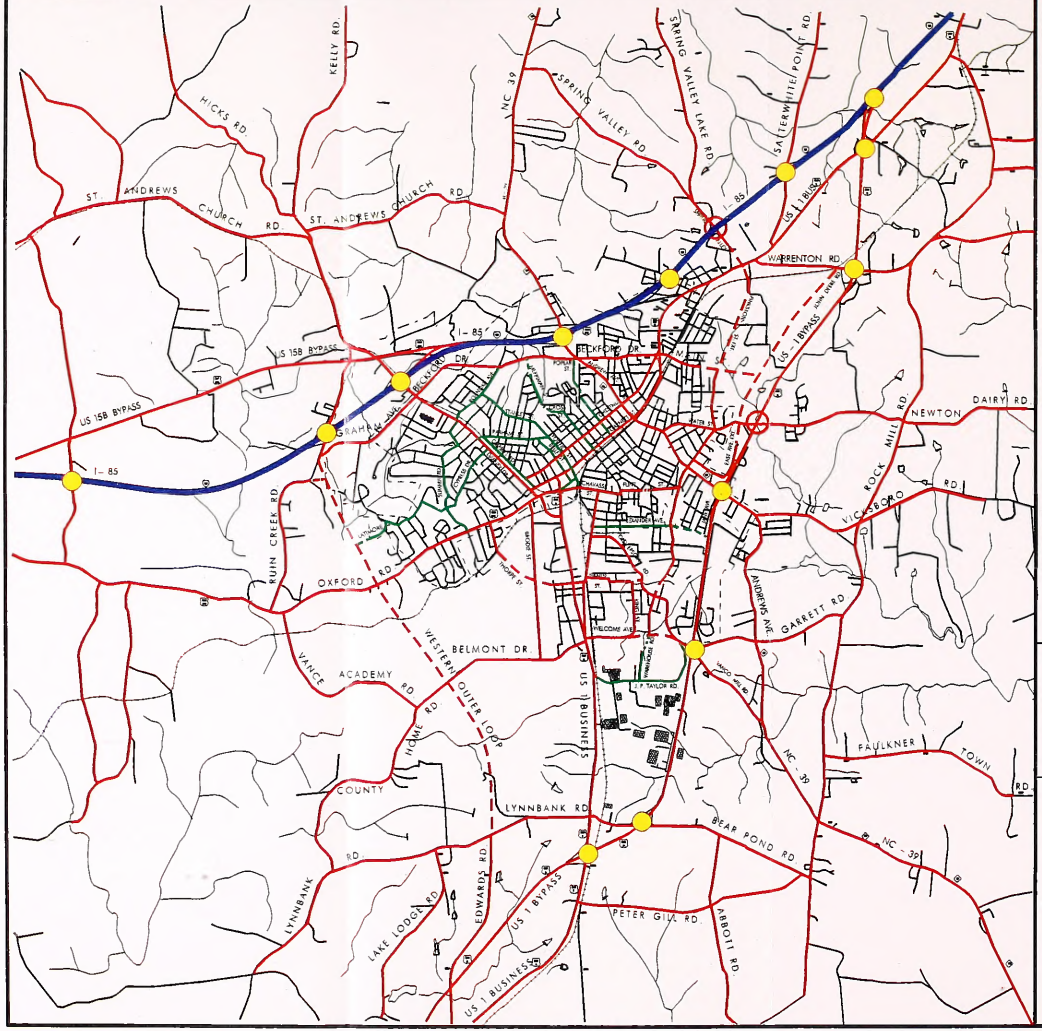
2) Encouraging local businesses to stagger work hours will decrease traffic volumes in the peak travel hours.

3) A continuing program to assure proper timing and phasing of all traffic signals will reduce traffic delays. Proper signal progression can have significant positive impact on a corridor; this is especially true with US 1 Business, US 158 Bypass, US 158 Business, Dabney Drive, Andrews Avenue and Garnett Street. The Traffic Engineering Branch of the North Carolina Department of Transportation is implementing some new high impact congestion management strategies and techniques. As for the Planning Area, implementation of a fully actuated, closed loop signal system controlling the existing major intersections located along US 158, US 1 Business, Dabney Drive, Andrews Avenue, Beckford Drive, Garnett Street and Chestnut Street is recommended.

4) Protection of access control is one of the areas where a significant contribution can be made. The limiting of driveway permits along US 1 Bypass, US 1 Business, US 158 Bypass, US 158 Business and the construction of a partial controlled access Western Outer Loop are good places to begin.

5) Offset intersections contribute to congestion and by correcting the offset intersections, capacity and safety will be improved.

6) A single unprotected left turning car can take the capacity equivalent of five through vehicles. The cross-section recommendations presume that the left turns at key intersections are provided.



HENDERSON
THOROUGHFARE
PLAN

LEGEND

	EXISTING	PROPOSED
FREEWAY		
MAJOR THOROUGHFARE		
MINOR THOROUGHFARE		
INTERCHANGE		
GRADE SEPARATION		

ADOPTED BY:

CITY OF HENDERSON:	OCTOBER 10, 1994
RECOMMENDED BY STATEWIDE PLANNING BRANCH:	OCTOBER 17, 1994
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION:	NOVEMBER 4, 1994

FIGURE 10

HENDERSON

VANCE COUNTY

NORTH CAROLINA

PREPARED BY THE
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS STATEWIDE PLANNING BRANCH

IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

OCTOBER 6, 1994

VII. IMPLEMENTATION

When developing a thoroughfare plan, existing and future deficiencies in the transportation system are found and a strategy is devised to solve these problems by improving existing facilities and/or constructing new ones. Once this is done the plan must be implemented. Methods used to implement the thoroughfare plan as well as funding sources, environmental concerns and the anticipated costs are discussed in this chapter.

State and Municipal Adoption of the Thoroughfare Plan

Chapter 136, Article 3A, Section 136-66.2 of the General Statutes of North Carolina provides that after development of a thoroughfare plan, the plan may be adopted by the governing body of the municipality and by the Department of Transportation to serve as the basis for future street and highway improvements. The General Statutes also require that, as part of the plan, the governing body of the municipality and Department of Transportation shall reach agreement on responsibilities for existing and proposed streets and highways included in the plan. Facilities which are designated a State responsibility will be constructed and maintained by the Division of Highways. Facilities which are designated a municipal responsibility will be constructed and maintained by the municipality.

After mutual plan adoption, the Department of Transportation will initiate negotiations leading to determining which of the existing and proposed thoroughfares will be a Department responsibility and which will be a municipal responsibility. Chapter 136, Article 3a, Section 136-66.1 of the General Statues provides guidance in the delineation of responsibilities. In summary, these statutes provide that the Department of Transportation shall be responsible for those facilities which serve volumes of through traffic and traffic from outside the area to major business, industrial, governmental, and institutional destinations located inside the municipality. The municipality is responsible for those facilities which serve primarily internal travel.

Thoroughfare plan adoption enables other planning tools such as the subdivision ordinances, zoning ordinances, official street map, and capital improvement programs to be used to assist in plan implementation and thus minimize public cost and land use disruption (See Table 7).

TABLE 7

FUNDING SOURCES AND METHODS RECOMMENDED FOR IMPLEMENTATION OF PROJECTS									
PROJECT	Funding Sources				Methods of Implementation				
	Local Funds	TIP Funds	Indust. Access	Small Urban	T-fare Plan	Subdiv. Ord.	Zoning Ord.	Future Street Lines	Development Review
Western Outer Loop		X			X		X		X
Pinkston Street Extension		X		X	X	X	X		X
Andrews Ave. Widen		X		X	X	X	X		X
Thorpe Street Extension	X			X	X	X			X
Main Street Extension	X	X		X	X	X			X
East Street Extension		X	X	X	X	X			X

Methods Used to Protect Adopted Thoroughfare Plan

Subdivision Controls

A subdivision ordinance requires that every subdivider submit to the Municipal Planning Commission a plot of his or her proposed subdivision. Certain standards must be met by the developer before he or she can be issued a building permit to construct the development. Through this process, it is possible to reserve or protect the necessary rights-of-way for proposed streets which are a part of the thoroughfare plan and to require street construction in accordance with the plan.

Since some of the proposed thoroughfares, such as the Western Outer Loop, Pinkston Street Extension and East Avenue Extension are outside the existing Henderson City Limits, it is recommended that additional building setbacks and/or right-of-way reservation conforming to the Henderson Thoroughfare Plan recommendations also be adopted in the Vance County Thoroughfare Plan. This will allow for orderly implementation of the plan in fringe areas without disrupting adjoining land owners.

Zoning

A zoning ordinance can be beneficial to thoroughfare planning by designating appropriate locations of various land uses and setting allowable densities of residential development. This provides a degree of stability on which to make future traffic projections and to plan streets and highways.

Other benefits of a good zoning ordinance are: (1) the establishment of standards of development which will aid traffic operations on major thoroughfares and (2) the minimization of strip commercial development which creates traffic friction and increases the traffic accident potential.

Future Street Line Ordinances

This ordinance is a particular benefit where widening of a street will be necessary at some time in the future. A municipality with legislative approval may amend its charter to be empowered to adopt future street line ordinances. Through a metes-and-bounds description of a street's future right-of-way requirements, the municipalities may prohibit new construction or reconstruction of structures within the future right-of-way. This approach requires specific design of the facility and would usually require surveys and public hearings to allow affected property owners to know what to expect and to make necessary adjustments without undue hardship. A specific ordinance can be enacted for selected

Roads, such as Andrews Avenue and US 1 Business in Henderson.

Development Reviews

Often the municipality is the first point of contact for development interest. Any development that may impact a State maintained street or highway must be reviewed by the Department of Transportation. For example, driveway access to a State-maintained street or highway is reviewed by the District Engineer's office and the Traffic Engineering Branch of the Department of Transportation prior to access being allowed. If this is done at an early stage it is often possible to significantly improve the development's accessibility at minimal expense. In the case of thoroughfare planning, if a shopping center or industry is going to locate in the path of a proposed roadway, the review process may provide an opportunity to modify the site to allow for the future roadway.

Roadway Corridor Official Map

North Carolina General Statutes 136-44.50 through 133-44.53 are collectively designated as the "Roadway Corridor Official Map Act." For cities contemplating the adoption of a Roadway Corridor Map, more commonly referred to as an Official Street Map, there are several things to consider prior to implementation. First and foremost, it should be recognized that an Official Street Map designation places severe, but temporary, restrictions on private property rights. These restrictions are in the form of a prohibition for a period of up to three years on the issuance of building permits or the approval of subdivisions of property lying within an Official Street Map corridor. This authority should be used carefully and only in cases where less restrictive powers will be ineffective.

The statute establishing the Official Street Map authority is fairly explicit in outlining the procedures to be followed and the types of projects to be considered. As required by the statute, a project being considered for an Official Street Map must be programed in the State's Transportation Improvement Program (TIP) or included in a locally adopted Capital Improvements Program in addition to appearing on the adopted street system plan. The Statute states that the Capital Improvements Program must be for a period of ten years or less and must identify the estimated cost of acquisition and construction of the proposed project as well as the anticipated financing.

The Program Development Branch of the North Carolina Department of Transportation is responsible for facilitating the adoption of Official Street Maps. Cities considering Official Street Map projects should contact this branch for their "Guidelines for Municipalities Considering Adoption of

Roadway Corridor Maps" at:

NC Department of Transportation
Program Development Branch
Post Office Box 25201
Raleigh, NC 27611

Funding Sources

Capital Improvement Program

A capital improvement program makes it easier to build a planned thoroughfare system. This capital improvement program consists of two lists of projects. The first is a list of highway projects that are designated as a municipal responsibility and are to be implemented with municipal funds. The second is a list of local projects designated as State responsibility to be included in the Transportation Improvement Program.

Transportation Improvement Program

North Carolina's Transportation Improvement Program (TIP) is a document which lists all major construction projects the Department of Transportation plans for the next seven years. Similar to local Capital Improvement Program projects, TIP projects are matched with projected funding sources. Each year when the TIP is updated, completed projects are removed, programed projects are advanced, and new projects are added.

During annual TIP public hearings, municipalities request projects such as the extension of Booker Dairy Road to be included in the TIP. A Board of Transportation member reviews all of the project requests in a particular area of the state. Based on the technical feasibility, need, and available funding, the board member decides which projects will be included in the TIP. In addition to highway construction and widening, TIP funds are available for bridge replacement projects, highway safety projects, public transit projects, railroad projects, and bicycle projects.

Industrial Access Funds

If an industry wishes to develop property that does not have access to a state maintained highway and certain economic conditions are met, then funds may be made available for construction of an access road.

Small Urban Funds

Small Urban funds are annual discretionary funds made to municipalities with qualifying projects. The current maximum amount is $150,000 per year per project. A city may have

multiple projects. Requests for Small Urban Fund assistance should be directed to the appropriate Board of Transportation member and Division Engineer.

Other Funding Sources

1. Assess user impact fees to fund transportation projects. These fees, called "facility fees" in the legislation, are based upon "reasonable and uniform considerations of capital costs to be incurred by the town as a result of new construction. The facility fee must bear a direct relationship to additional or expanded public capital costs of the community service facilities to be rendered for the inhabitants, occupants of the new construction, or those associated with the development process".

2. Enact a bond issue to fund street improvements.

3. Consider the possibility of specific projects qualifying for federal demonstration projects funds.

4. Adopt a collector street plan that would assess the buyer or property owners for street improvement.

5. Charge a special assessment for utilities; for example increase water and sewer bills to cover the cost of street improvements.

Environmental Concerns

The importance of the environment is becoming increasingly apparent and there is a need to make every effort to preserve it. In looking at proposed thoroughfares it is desirable to locate a corridor that will do the least amount of damage to the environment. Environmental factors usually considered in highway project evaluation can be divided into three major categories--physical, social and/or cultural, and economic environmental considerations (Table 7). Many of these are accounted for when a project is evaluated with respect to user benefits, cost and economic development potential. However, thirteen additional environmental factors need to be considered in these evaluations. They are the environmental impacts of a project on (1) air quality (2) water resources, (3) soils and geology, (4) wildlife, (5) vegetation, (6) neighborhoods, (7) noise, (8) educational facilities, (9) churches, (10) park and recreational facilities, (11) historic sites and landmarks, (12) public health and safety, and (13) aesthetics.
The summation of both positive and negative impacts probabilities with respect to these factors provides a measure of the relative environmental impact of a project.

Table 8 may be used as a guideline for interpreting the "Probable Impact" values in Table 9.

TABLE 8

PROBABILITY ESTIMATION GUIDE	
Subjective Evaluation	Impact Probability
Excellent - very substantial	0.90
Very good - substantial	0.60
Fair - some	0.40
Poor - none	0.10

TABLE 9

Environmental Considerations		
Physical Environment	**Social and/or Cultural Environment**	**Economic Environment**
Air Quality	Housing	Businesses
Water Resources	Neighborhoods	Employment
Wildlife	Noise	Economic Development
Vegetation	Education Facilities	Public Utilities
	Churches	Transportation Costs
	Park and Recreational Facilities	Capital Costs
	Public Health and Safety	Operation and Maintenance Costs
	Aesthetics	

Listed below are impacts associated with the recommended thoroughfare plan:

- The construction of the Western Outer Loop will cause both positive and negative impacts. The positive impacts are: (1) the proposed roadway will reduce travel time for the travellers in West Henderson and between US 1 Bypass and I-85; (2) the proposed roadway will reduce the number of accidents on Dabney Drive and US 1 Business by decreasing the number of

vehicles in downtown Henderson and will provide a safer environment for motorists; (3) construction of Western Outer Loop will provide for a much needed loop facility; and (4) construction of the Western Outer Loop should stimulate and provide for the growth and development in the Planning Area. The negative impact loop facility. The negative impact is due to crossing of the Red Bud Creek, Little Creek, Ruin Creek, Joes Branch and the wetlands and wildlife habitat associated with them.

- The construction of the Pinkston Street Extension also has both positive and negative impacts. The positive impacts are: (1) it will reduce congestion on Andrews Avene and should lower carbon monoxide levels improving air quality; and (2) the Pinkston Street Extension will function as eastern inner loop facility thus reduces congestion on local and minor streets in north-east Henderson. The negative impacts are due to crossing of the wetlands and streams and a few residential units in the vicinity of the proposed roadway. It is suggested that the use of "best management practices" (reduce side slopes, no staging in lowland sites, minimize wetland canopy removal, limited fill placement, etc.) be employed in an effort to minimize impacts to affected wetlands. Replacement of filled wetlands could be mitigated by the creation of enhancement areas contiguous to existing wetlands adjacent to the project.

Construction Priorities and Cost Estimates

Construction priorities will vary depending on what criteria are considered and what weight is attached to the various criteria. Most people would agree that improvements to the major thoroughfare system and major traffic routes would be more important than minor thoroughfares where traffic volumes are lower. To be in the North Carolina Transportation Improvement Program, a project must show favorable benefits relative to costs and should not be prohibitively disruptive to the environment. The potential cost estimate of four major projects for the Planning Area are given in Table 10. The evaluation of these projects with respect to user benefits, probability that economic development will be stimulated and environmental impact is given in Table 11.

Thoroughfare improvement needs identified and evaluated in the Henderson Thoroughfare Plan are:

- construction of the Henderson Western Outer Loop from Bear Pond Raod/Lynnbank Road (SR 1115) to Ruin Creek Road (SR 1128). TIP Project U-2527 and its extension to Bear Pond Road.

- The extension of Pinkston Street (SR 1214) to Spring Valley Road (SR 1317);

- The extension of Thorpe Street to Miriam Street;

- The extension of East Avenue (SR 1208) to function as a service road for US 1 Bypass.

TABLE 10

Potential Project Cost Estimates Investigated Projects

Project	Project Description	Total Cost Including R/W
1	Western Outer Loop	$ 7,415,000
2	Extension of Pinkston Street	$ 2,800,000
3	Thorpe Street Extension	$ 1,110,000
4	East Street Ext. to John Deere	$ 2,900,000

TABLE 11

Benefits Evaluation for Investigated Projects

Project	Benefits (1000's)	Costs (1000's)	Length Mile	Benefits per Mile	Econ. Dev. Potential	Eviron. Impact
Western Loop	$49,800	$7,026	4.00	$12,450	0.60	+0.6 -0.3
Pinkston St. Extension	$14,740	$2,275	1.37	$10,759	0.50	+0.5 -0.3
Thorpe St. Extension	$3,410	$1,110	0.75	$4,546	0.40	+0.4 -0.2
East Street Extension	$6,352	$3,567	1.90	$3,343	0.50	+0.5 -0.1

APPENDICES

APPENDIX A

TRAVEL FORECASTING MODELS

In order to develop an efficient Thoroughfare Plan for the Henderson Planning Area it was necessary to develop and calibrate a travel model of the Planning Area. To develop a traffic model, the following are necessary: (1) define the Planning Area, (2) collect traffic counts on existing streets and socio-economic data by traffic analysis zones, (3) determine the trip generation characteristics of the Planning Area, (4) calibrate the traffic model so that it duplicates traffic patterns of the Planning Area, (5) project the socio-economic data to the design year, (6) estimate design year travel demand. Figure A-1 illustrates the modeling process. Once the socio-economic data has been projected to the design year the model may be used to estimate design year traffic volumes, evaluate various street system deficiencies, and evaluate alternate solutions to the problems.

The Planning Area and Street Network

Figure 3 in Chapter III shows the Planning Area and its division into 76 zones. Two control lines called screen lines A and B were drawn across the Planning Area. The screen lines are used in calibrating the traffic model. Traffic counts along these lines indicate how much traffic is moving from one side of the Planning Area to another. The screen lines follow natural boundaries in order to minimize the number of places that traffic can cross them.

Screen Line AA runs north to south starting at the Planning Area boundary east of the intersection of NC 39 and SR 1317 (Spring Valley Road) and crosses SR 1317 (Spring Valley Road), NC 39, I-85, SR 1165 (Beckford Drive), SR 1226 (Chestnut Street), Garnett Street, SR 1228 (Chavasse Avenue), SR 1143 (St. Mathews Street), SR 1138 (Welcome Street), SR 1139 (J.P. Taylor Road), SR 1115 (Bear Pond Road), US 1 Bypass and SR 1548 (Peter Gill Road).

Screen Line BB begins on the east side of the Planning Area and runs northwest following the Seaboard Coast Line Railroad and crosses SR 1519 (Rock Mill Road), NC 39, US 1 Bypass, SR 1148 (Old Epsom Road), SR 1143 (Nicholas Street),US 1 Business (Raleigh Road), US 158 Business (Oxford Road), Parham Street, SR 1163 (Roanoke Avenue), SR 1165 (Beckford Drive), I-85, US 158 Bypass, and SR 1309 (Saint Andrews Church Road).

The Planning Area was divided into 76 zones for data collection and aggregation. The data from the dwelling unit

survey and the employment survey were collected on the basis of these traffic zones (See Tables A-2 and A-3). The projection of the socio-economic data to the future year is also done on the basis of traffic zones (See Tables A-4 and A-5). Traffic zone boundaries are based, where possible, on physical features to aid in on-the-ground recognition.

The Base Year Network

The purpose of the traffic model is to replicate the existing traffic volumes on the transportation system. Therefore, it is necessary to represent the existing transportation system in a realistic model. There is a delicate balance between having too many streets on the model thereby hindering calibration and not having enough streets to realistically duplicate existing conditions. Generally all the major arterials and major collector streets need to be represented in the system model. The major highways represented by the model are: I-85, US 1 Bypass, US 1 Business, US 158 Bypass, US 158 Business, NC 39, SR 1518, SR 1533, SR 1165 (Beckford Drive), SR 1226 (Chestnut Street), SR 1519 (Rock Mill Road), SR 1001 (Warrenton Road), SR 1114 (Edwards Road), SR 1115 (Bear Pond Road), SR 1146 (Old Epsom Road), SR 1162 (Dabney Drive), SR 1303 (Hicks Road), SR 1304 (Dabney Road), SR 1317 (Spring Valley Road), SR 1318 (Spring Valley Lake Road), and SR 1101 (Belmont Drive).

Street capacity is an important component of the model. The volume/capacity ratio (v/c) gives us our best indication of present and future traffic congestion. The capacity ranges for the Henderson Planning Area model are shown in Table A-1.

Speed and distance are the major factors that define the minimum time paths from zone to zone. The model uses the minimum time paths as the basis for assigning traffic to streets.

DATA REQUIREMENTS

In order to produce an adequate traffic model of the Planning Area, two additional types of data are required. First, traffic counts must be taken to provide a basis for calibrating the model. Second, socio-economic data (housing counts and an employment survey) are necessary in order to generate traffic for the model. The 1994 socio-economic data collected for the Planning Area are shown in Table A-2 and Table A-3.

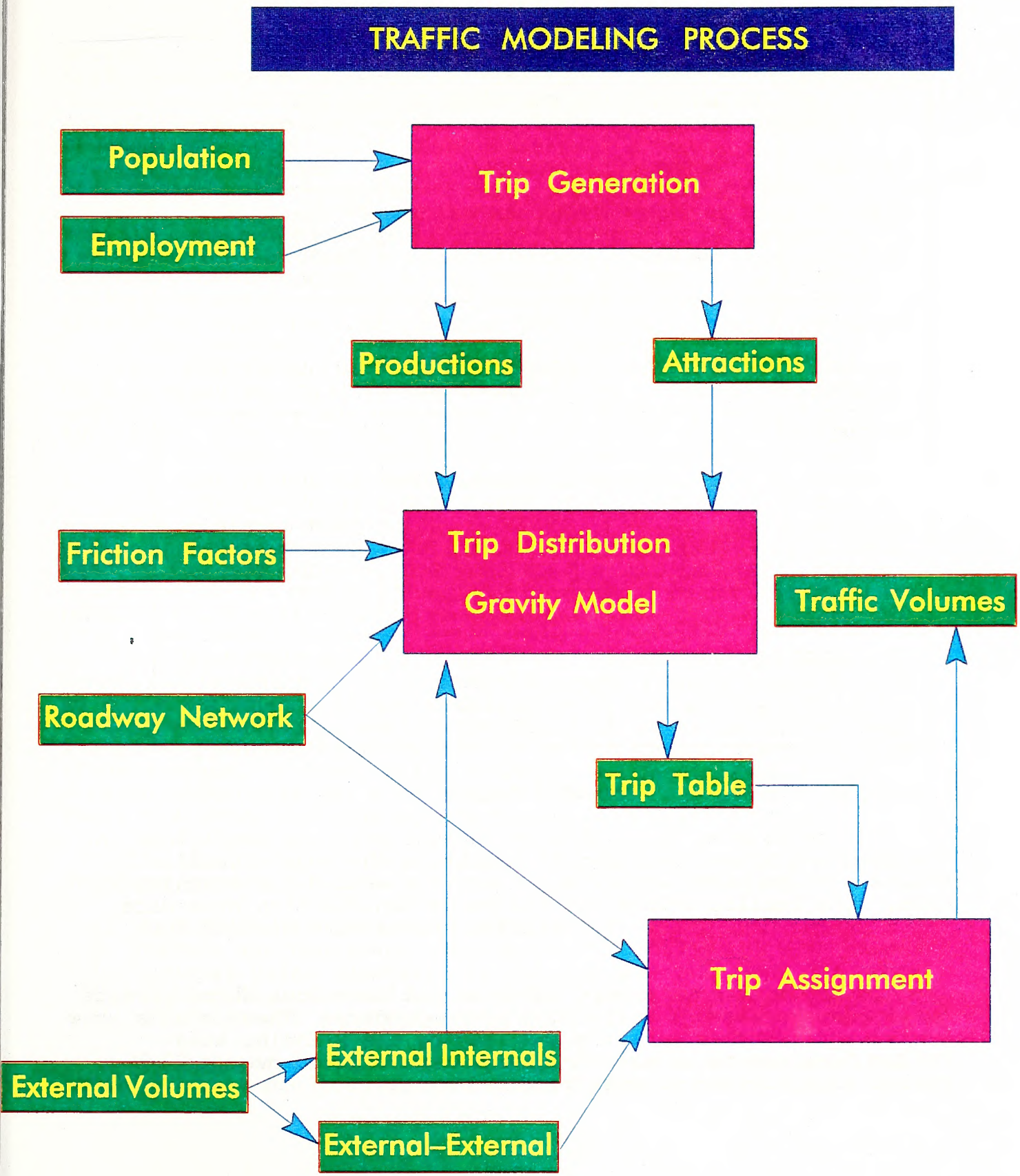

TRAFFIC MODELING PROCESS
Population
Employment
Trip Generation
Productions
Attractions
Friction Factors
Trip Distribution
Gravity Model
Traffic Volumes
Roadway Network
Trip Table
Trip Assignment
External Internals
External Volumes
External–External

FIGURE A – 1

TABLE A-1

DAILY CAPACITY FOR LEVEL OF SERVICE "D"			
SECTION	RURAL	SUBURBAN	URBAN
FREEWAY			
4-LANE	54,000	54,000	54,000
6-LANE	81,000	81,000	81,000
DIVIDED			
4-LANE	50,000	37,000-41,700	18,000-22,000
6-LANE	75,700	56,500-62,600	30,000-34,000
UNDIVIDED			
3-LANE	23,200	20,300-21,400	12,000-16,000
4-LANE	48,000	33,500-39,400	18,000-22,000
5-LANE	49,000	35,600-39,400	24,000-28,000
6-LANE	71,900	50,300-55,700	30,000-34,000
7-LANE	73,400	53,400-59,200	36,000-40,000
TWO-LANE			
9' LANES	9,000	8,500	8,000
10' LANES	11,000	10,500	9,500
11' LANES	12,000	11,500	11,000
12' LANES	13,000	12,500	12,000

Traffic Counts

The model must be calibrated against existing conditions in the Planning Area. In order to calibrate the model, traffic counts must be taken at various locations around the Planning Area. The traffic counts for the Henderson Planning Area were taken during May, 1993. The traffic counts were divided into three types:

Cordon line counts were taken at all locations where streets or highways crossed the Planning Area boundary. These counts show how much traffic is entering and leaving the Planning Area. Cordon line counts on major highways were counted over a 72-hour period with traffic volumes recorded hourly.

Traffic counts were taken everywhere that a street crossed a screen line. These counts were used to determine the volume of traffic moving across major portions of the Planning Area. These counts were also the primary accuracy check of the traffic model. All of the screen line counts were 72-hour machine recording counts.

Other traffic counts, coverage counts, were taken on various streets and highways within the Henderson Planning Area. These traffic counts were taken over a 24-hour period and show the volume during the 24-hour period. These coverage counts are a secondary accuracy check on the model. The model can be calibrated and fine tuned to closely duplicate the existing traffic on existing streets using the coverage count volumes.

Vehicle classification counts were taken on I-85, US 1 Bypass, US 158 Bypass and NC 39. These traffic counts, in addition to giving an indication of the number of vehicles using the roads, give some indication of the vehicle mix.

Socio-economic Data

The required socio economic data has two forms: a dwelling unit count and an employment survey. The dwelling unit count is used as the generator of traffic. Employment is used as a trip attractor in the model. The model assumes that dwelling units produce trips while jobs attract trips.

The best indicator of the average number of trips made from a household in a day is the household income. Since there is no adequate method for determining household income, the type and quality of housing is used as an indicator of household income. The housing inventory is divided into five categories: excellent, above average, average, below average, and poor. Each of the housing categories has a slightly different trip generation rate. Table A-2 shows the housing counts for each traffic zone.

The employment survey of the Planning Area was classified by Standard Industrial code into 5 categories (See Table A-3):

1. Industrial including agriculture and construction (SIC 1-49)
2. Retail and Wholesale (SIC 50-54, 56, 57, 59)
3. Special Sales (Restaurants and Gas Stations) (SIC 55, 58)
4. Office (Private and Government) (SIC 60-67, 91-97)
5. Professional Services (SIC 70-89)

The category totals, by zone, were input into a regression equation which produces an attraction factor for each zone.

TABLE A-2
PLANNING AREA DWELLING UNIT SUMMARY 1994

ZONE	EXCELLENT	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE	POOR	TOTAL DU'S
1	0	1	2	0	0	3
2	0	0	0	15	7	22
3	0	1	15	2	0	18
4	0	1	6	15	0	22
5	0	33	1	11	165	210
6	0	23	116	70	18	227
7	0	0	11	108	25	144
8	1	2	47	49	6	105
9	0	16	40	86	12	154
10	0	26	17	26	6	75
11	0	0	41	10	0	51
12	0	0	42	149	6	197
13	0	9	58	40	3	110
14	0	1	193	39	13	246
15	0	4	83	164	61	312
16	0	0	113	195	0	308
17	0	0	133	73	52	258
18	4	4	15	81	2	106
19	0	10	220	22	0	252
20	1	31	56	174	95	357
21	0	0	187	0	0	187
22	0	20	8	2	2	32
23	0	6	43	115	37	201
24	64	142	280	8	0	494
25	1	56	142	151	5	355
26	0	109	204	0	0	313
27	0	2	58	29	0	89
28	81	28	25	8	1	143
29	0	1	0	0	0	1
30	0	11	22	110	20	163
31	0	0	56	188	51	295
32	0	0	0	34	49	83
33	1	1	17	21	2	42
34	2	0	1	3	4	10
35	0	4	45	96	90	235
36	0	7	98	42	81	228
37	0	0	91	93	115	299
38	2	3	54	179	52	290
39	0	2	79	67	24	172
40	0	2	12	9	31	54
41	1	9	24	32	14	80
42	0	0	8	130	53	191
43	0	3	102	74	7	186
44	0	6	63	7	1	77
45	0	2	6	11	14	33
46	0	0	25	27	25	77
47	0	2	19	54	8	83
48	43	15	66	189	40	353
49	0	12	77	24	28	141
50	0	9	56	67	50	182

TABLE A-2
PLANNING AREA DWELLING UNIT SUMMARY 1994

ZONE	EXCELLENT	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE	POOR	TOTAL DU'S
51	1	17	44	36	3	101
52	0	2	49	3	9	63
53	35	7	14	6	1	63
54	18	32	18	1	2	71
55	0	39	6	2	3	50
56	1	7	26	8	0	42
57	0	7	2	3	0	12
58	4	7	19	48	22	100
59	0	0	49	100	21	170
60	0	0	0	6	1	7
61	0	3	20	10	1	34
62	0	0	28	21	3	52
63	1	1	4	5	1	12
64	2	5	37	26	3	73
65	0	4	44	39	51	138
66	5	11	42	24	1	83
67	0	0	7	1	1	9
68	64	12	50	15	0	141
69	0	8	88	23	5	124
70	0	1	10	18	68	97
71	0	2	32	16	8	58
72	0	23	24	20	2	69
73	14	6	32	11	4	67
74	2	9	57	19	12	99
75	0	6	10	11	15	42
76	1	0	12	3	2	18
TOTALS	349	823	3801	3574	1514	10061

TABLE A-3
PLANNING AREA EMPLOYMENT SUMMARY 1994

ZONE	SIC 1-49 INDUSTRY	50-54, 56,57,59 SALES	55,58 SPECIAL SALES	60-67 91-97 OFFICE	70-89 SERVICE	TOTAL EMP.	COMMERCIAL CAR AND TRUCK
1	43	647	20	350	120	1180	110
2	4	10	7	5	27	53	2
3	19	39	5	35	130	228	45
4	3	33	9	4	59	108	0
5	105	9	0	0	46	160	27
6	31	46	1	53	35	166	4
7	0	2	0	5	3	10	0
8	47	14	3	76	183	323	0
9	0	0	9	0	13	22	15
10	0	6	0	4	2	12	0
11	0	0	0	0	71	71	0
12	0	0	6	0	0	6	3
13	9	52	0	0	31	92	0
14	0	0	0	0	74	74	4
15	0	201	3	0	12	216	0
16	0	0	0	25	6	31	0
17	888	5	0	0	37	930	40
18	2	0	0	0	0	2	0
19	61	36	76	37	201	411	60
20	11	53	2	0	12	78	0
21	258	118	141	0	27	544	0
22	1060	44	2	0	26	1132	87
23	201	99	109	0	847	1256	1
24	65	402	44	58	65	634	9
25	5	22	60	98	124	309	7
26	0	0	0	0	30	30	0
27	8	0	0	0	3	11	2
28	0	5	51	2	29	87	0
29	112	190	187	5	0	494	48
30	142	17	10	30	33	232	11
31	512	3	3	0	0	518	0
32	0	2	0	0	0	2	0
33	787	20	2	0	15	824	0
34	0	0	0	0	0	0	0
35	151	6	12	0	17	186	12
36	210	0	0	0	2	212	2
37	28	2	3	0	2	35	15
38	736	0	0	0	0	736	11
39	0	0	0	0	0	0	0
40	43	0	0	0	2	45	28
41	90	86	58	7	149	390	0
42	31	42	9	0	20	102	37
43	23	203	50	10	251	537	13
44	0	0	0	0	2	2	2
45	114	0	0	0	1	115	56
46	4	3	0	0	2	9	2
47	0	4	0	0	2	6	3
48	0	6	0	6	14	26	0
49	13	4	0	0	0	17	5
50	91	2	2	140	0	235	26

TABLE A-3
PLANNING AREA EMPLOYMENT SUMMARY 1994

ZONE	SIC 1-49 INDUSTRY	50-54, 56,57,59 SALES	55,58 SPECIAL SALES	60-67 91-97 OFFICE	70-89 SERVICE	TOTAL EMP.	COMMERCIAL CAR AND TRUCK
51	0	10	38	4	8	60	0
52	0	0	0	0	1	1	0
53	0	0	0	0	94	94	0
54	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0
56	25	4	72	12	33	146	0
57	0	0	0	0	0	0	0
58	1345	0	0	0	169	1514	14
59	106	14	0	0	0	120	60
60	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0
62	0	3	0	0	0	3	1
63	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0
65	0	0	3	0	0	3	0
66	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0
69	4	6	0	0	24	34	0
70	0	0	1	0	1	2	0
71	0	4	0	0	1	5	0
72	0	0	2	0	7	9	0
73	0	0	0	0	0	0	0
74	2	0	0	0	0	2	0
75	0	0	0	0	4	4	0
76	184	5	0	0	0	189	0
TOTALS	7573	2479	1000	966	3068	15086	762

TABLE A-4
PLANNING AREA DWELLING UNIT SUMMARY 2020

ZONE	EXCELLENT	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE	POOR	TOTAL DU'S
1	0	1	2	0	0	3
2	0	0	0	15	7	22
3	0	1	15	2	0	18
4	0	1	6	15	0	22
5	0	33	8	11	165	217
6	0	23	116	80	18	237
7	0	0	11	108	25	144
8	1	2	47	49	6	105
9	0	21	70	86	12	189
10	0	26	17	26	6	75
11	0	0	41	10	0	51
12	0	0	42	149	6	197
13	0	9	58	40	3	110
14	0	1	193	39	13	246
15	0	4	83	164	61	312
16	0	0	133	215	20	368
17	0	0	193	113	72	378
18	14	14	55	91	2	176
19	0	10	220	22	0	252
20	1	31	56	174	95	357
21	0	0	187	0	0	187
22	20	40	28	2	2	92
23	80	56	43	115	37	331
24	64	142	300	8	0	514
25	1	56	142	151	5	355
26	0	149	244	0	0	393
27	0	152	158	29	0	339
28	141	228	25	8	1	403
29	0	1	0	0	0	1
30	0	11	22	110	20	163
31	0	0	56	218	81	355
32	0	0	0	74	89	163
33	1	1	37	41	12	92
34	4	0	41	43	14	102
35	0	14	79	136	90	319
36	0	9	128	72	81	290
37	0	0	141	253	115	509
38	2	3	154	179	52	390
39	0	2	129	107	24	262
40	0	2	42	39	31	114
41	1	9	24	32	14	80
42	0	0	8	130	53	191
43	0	3	102	74	7	186
44	0	6	133	37	1	177
45	0	2	6	11	14	33
46	0	0	35	47	25	107
47	0	2	49	84	8	143
48	43	15	136	259	40	493
49	0	12	197	124	28	361
50	0	9	136	117	50	312

TABLE A-4
PLANNING AREA DWELLING UNIT SUMMARY 2020

ZONE	EXCELLENT	ABOVE AVERAGE	AVERAGE	BELOW AVERAGE	POOR	TOTAL DU'S
51	1	17	114	86	3	221
52	0	2	99	33	9	143
53	35	7	84	6	1	133
54	18	32	98	1	2	151
55	114	99	36	2	3	254
56	31	7	56	38	0	132
57	0	7	22	23	0	52
58	4	7	19	48	22	100
59	0	0	49	100	21	170
60	0	0	0	6	1	7
61	0	3	20	10	1	34
62	0	0	48	21	3	72
63	1	1	24	5	1	32
64	2	5	57	26	3	93
65	0	4	74	39	51	168
66	5	11	72	24	1	113
67	0	0	27	1	1	29
68	87	12	50	15	0	164
69	0	8	108	23	5	144
70	0	1	30	18	68	117
71	0	2	52	16	8	78
72	0	23	44	20	2	89
73	14	6	43	11	4	78
74	2	9	72	19	12	114
75	0	6	20	11	15	52
76	1	0	12	3	2	18
TOTALS	688	1370	5478	4514	1644	13694

TABLE A-5
PLANNING AREA EMPLOYMENT SUMMARY 2020

ZONE	SIC 1-49 INDUSTRY	50-54, 56,57,59 SALES	55,58 SPECIAL SALES	60-67 91-97 OFFICE	70-89 SERVICE	TOTAL EMP.	COMMERCIAL CAR AND TRUCK
1	43	647	20	350	120	1180	110
2	4	10	7	5	27	53	2
3	19	39	5	35	130	228	45
4	3	33	9	4	59	108	0
5	105	9	0	0	46	160	27
6	31	46	1	53	35	166	4
7	0	2	0	5	3	10	0
8	47	14	3	76	183	323	0
9	0	0	9	0	13	22	15
10	0	6	0	4	2	12	0
11	0	0	0	0	71	71	0
12	0	0	6	0	0	6	3
13	9	52	0	0	31	92	0
14	0	0	0	0	74	74	4
15	0	201	3	0	72	276	0
16	0	0	0	25	6	31	0
17	888	5	0	0	37	930	40
18	2	0	0	0	0	2	0
19	61	36	76	37	201	411	60
20	11	53	2	0	12	78	0
21	258	118	191	0	27	594	0
22	1240	44	2	0	26	1312	122
23	201	299	109	0	847	1456	11
24	65	402	44	58	65	634	9
25	5	22	60	98	124	309	7
26	0	0	0	0	90	90	0
27	8	40	0	0	3	51	12
28	0	5	51	2	129	187	20
29	112	250	187	55	0	604	48
30	142	17	10	30	33	232	11
31	512	3	3	0	0	518	0
32	0	2	0	0	0	2	0
33	787	20	2	0	15	824	0
34	0	0	0	0	100	100	0
35	151	6	12	0	117	286	22
36	430	0	0	0	2	432	22
37	228	2	3	0	2	235	40
38	736	0	0	0	0	736	11
39	200	0	0	0	0	200	20
40	183	0	0	0	2	185	43
41	90	86	98	7	149	430	10
42	31	42	9	0	20	102	37
43	23	203	50	10	251	537	13
44	0	0	0	0	62	62	12
45	314	0	0	0	1	315	76
46	4	3	0	0	62	69	12
47	0	4	0	0	2	6	3
48	0	6	0	56	14	76	0
49	13	4	0	0	0	17	5
50	291	2	2	140	0	435	46

TABLE A-5
PLANNING AREA EMPLOYMENT SUMMARY 2020

ZONE	SIC 1-49 INDUSTRY	50-54, 56,57,59 SALES	55,58 SPECIAL SALES	60-67 91-97 OFFICE	70-89 SERVICE	TOTAL EMP.	COMMERCIAL CAR AND TRUCK
51	0	10	38	4	68	120	10
52	0	60	0	0	1	61	0
53	0	0	60	0	94	154	20
54	0	0	0	0	63	63	10
55	0	0	0	0	0	0	0
56	25	104	72	12	33	246	0
57	0	42	0	0	0	42	0
58	1345	0	0	0	169	1514	14
59	106	14	0	0	0	120	60
60	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0
62	0	3	0	0	0	3	1
63	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0
65	0	0	3	0	0	3	0
66	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0
68	0	144	0	0	0	144	0
69	4	6	0	100	24	134	0
70	0	0	1	0	1	2	0
71	0	4	0	0	1	5	0
72	0	0	2	0	7	9	0
73	0	0	0	0	0	0	0
74	2	0	0	0	0	2	0
75	0	0	0	0	4	4	0
76	503	5	0	0	0	508	60
TOTALS	9232	3125	1150	1166	3731	18404	1097

Trip Generation

The trip generation process is the process by which external station volumes, housing data, commercial vehicles inventory, and employment data are used to generate traffic volumes that duplicate the traffic volumes on the street network. Through trip tables are developed using the Modlin approach.1 The gravity model is used to distribute the internally generated trips and the external-internal trips.

Traffic inside the planning area has three major components through trips, internal-external trips, and internal trips. The technical definition of a trip is slightly different than the definition of a trip used by the general public. Technically a trip only has one origin and one destination while the layman will often group, or chain, several short trips together as one longer trip. Through trips are produced outside the planning area and pass through the planning area enroute to a destination outside the planning area. Internal-external trips have one end point inside the planning area and one end point outside the planning area. Internal trips have both their origin and destination inside the planning area.

For clarity the internal trips are further subdivided into trip purposes. The trip purposes for Planning Area are: home-based work, other-home based, and non-home based.

Internal Data Summary

The Internal Data Summary (IDS) is the process that takes the external-internal traffic volumes, housing data, employment data, generation rates, and regression equations and generates the trip productions and trip attractions required by the gravity model. IDS is a simplified version of the Cross Class method of trip generation. The IDS process has been adapted to the microcomputer utilizing a PFS Plan Spreadsheet. The spreadsheet has three parts: housing/population worksheet, employment worksheet, and a calculation worksheet.

Housing units were stratified to account for differing trip generation rates for each classification. Table A-6 shows the individual generation rates. The trip generation rates for commercial vehicles, and taxis are also included in the table. The individual trip generation rates give an average trip generation rate for the Planning Area of 7.19 trips per dwelling unit (DU).

1- Modlin, D. G., Synthesis of Through Trip Patterns in Small Urban area, Unpublished Thesis NCSU, 1971, Raleigh, N. C.

TABLE A-6

TRIP GENERATION BY HOUSING TYPE	
CLASSIFICATION	GENERATION RATE
EXCELLENT	10.0
ABOVE AVERAGE	9.0
AVERAGE	8.0
BELOW AVERAGE	7.0
POOR	4.0
COMMERCIAL VEHICLES	7.4
TAXI	7.4

Trip attractions were produced using the regression equations developed for the Henderson Thoroughfare Plan Study. The regression equations consider trip attractions to be related to the employment characteristics of the traffic zones. The equations estimating trip attractions are as follows:

OHB $Y = 0.5X_1 + 1.4X_2 + 6.4X_3 + 2.6X_4 + 2.5X_5$
NHB $Y = 0.5X_1 + 1.4X_2 + 6.4X_3 + 2.6X_4 + 2.5X_5$
EXT $Y = 0.5X_1 + 1.4X_2 + 6.4X_3 + 2.6X_4 + 2.5X_5$

WHERE: Y = Attraction factor for each zone by trip purpose

X_1 = Industry (SIC codes 1-49)
X_2 = Retail (SIC codes 50-54, 56, 57, 59)
X_3 = Special Retail (SIC codes 55, 58)
X_4 = Office (SIC codes 60-67, 91-97)
X_5 = Services (SIC codes 70-76, 78-89, 99)

Special Retail (X_3) which is made up of fast food restaurants, convenience stores, gas stations and banks with drive-in windows operate at much higher traffic generation rates than traditional retail establishments which are listed as Retail (X_2).

The zonal attraction factors thus derived were adjusted so that the total attractions equaled the total productions. This adjustment was done by multiplying each zonal attraction factor by the ratio of total productions to total unadjusted attractions for each trip category.

The total trips generated by dwelling units and commercial vehicles were summed to produce the total internally generated

trips. Total internal trips were reduced by a reduction factor of 0.87 to account for the trips made by vehicles garaged inside the Planning Area but with destinations outside the Planning Area (these trips are included in the external station counts). The adjusted internal travel was separated into three purposes: home-based work (HBW) 24%, other-home based (OHB) 52%, and non-home based (NHB) 24%. Added to these internally generated trips are a component of internal trips that are generated by vehicles garaged outside the Planning Area. These trips are called secondary non-home based (NHBS) trips and they are calculated as follows:

NHBS = Ext-Int Trips - Ext-Int Trips Garaged inside P. A. x Factor

Factor ranges from 0.40 to 0.50 depending on the opportunities to make extra trips. 0.40 was used to compute the secondary non-home based trips for the Henderson Planning Area.

1994 NHBS = 0.40 (51,138 - 10,142) = 16,398
2020 NHBS = 0.40 (120,752 - 14,144) = 32,767

The output of the IDS program are trip productions and trip attractions for each zone divided into four trip purposes. home-based work (HBW), home-based other (HBO), non-home based (NHB) and external-internal (EI). The trips are segregated into trip purposes because different trip length frequency curves are associated with each trip purpose.

Internal Trip Distribution

Once the number of trips per traffic zone is determined the trips must still be distributed to other traffic zones. The preferred method of distributing internal trips, called the Gravity Model, states that the number of trips between Zone A and Zone B is proportional to the number of trips produced in Zone A multiplied by the number of trips attracted to Zone B multiplied by a travel time factor.

The travel time factor or friction factor (F) is critical to the gravity model distribution and must be derived empirically in the absence of origin-destination data. The travel time factor is dependent on the distance between the traffic zones and the time necessary to travel between traffic zones. The travel time factor is also dependent on the trip purpose. Friction factors and travel curve data used in the Planning Area model are shown in Tables A-9 and A-10 respectively.

Model Calibration

The purpose of a traffic model is to predict the traffic on a street system at some future point in time; however, if the model is not accurate it is useless for this purpose. Therefore the major test of a traffic model's validity is whether or not the model will duplicate the existing traffic pattern. The actual calibration of the model is an iterative process in which incremental changes are made either in the trip generation, trip distribution, or the street network. The purpose of each change is to allow the model to more accurately reflect the real world conditions upon which the model is based. Only when the model can adequately reflect the existing traffic pattern should it be used to predict traffic in the future year.

There are three checks made on the model. The first is to follow trips through all the steps involved in the model. The purpose of this check is to insure that no trips have been accidentally added to or subtracted from the model, and that no trips have been counted twice. The second check is to compare the model generated trips on the screenlines with the ground counts taken at the screenlines. A model is considered to accurately reflect the overall travel patterns if the model trips are from 95% to 105% of the ground counts on the screenlines. Table A-5 compares the ground counts with the model traffic volumes on the sreeenlines.

TABLE A-7

Actual vs. Modeled Screenline Totals

Screenline	Ground Count	Model Volume	Percent
A	43650	43845	100.45
B	50560	50703	100.28

The final check is to match the traffic volumes on the link counts with the ground counts on the links. The "link counts" can be used to find particular places in the network where there are problems.

Design Year Travel (Year 2020)

In order to make use of the model the base year data must be projected to reflect assumed conditions in the design year. Unfortunately development that will take place in the design year may not be in the places, size, or of the types anticipated. The Planning Area officials provided great assistance in the projection of socio-economic and land use data. The procedure in chapter III was utilized to project the population and employment of the Planning Area. Tables A-4 and A-5 show the projected socio-economic data for each zone.

The year 2020 travel was developed using the same techniques employed in synthesizing the 1990 travel. These travel patterns were estimated by using the design Year socio-economic data and utilizing the 1994 internal travel development procedures. The same trip generation rates were used for the year 2020 as for the base year 1994 (See Table A-6). These generation rates were applied to the DU's projected for each zone. The 2020 trip generation rates for trucks and commercially owned vehicles was assumed to remain at 7.4 trips per vehicle.

TABLE A-8

TRAVEL MODEL INPUT VARIABLES

TRIP PERCENTAGES BY PURPOSE	
Internal of Total	87%
HBW	24%
OHB	52%
NHB	24%

YEAR	PERSON/DU	PERSON/VEH
1994	2.67	1.38
2020	2.40	1.15

$$\text{INCREASE FOR GENERATION RATES} = \text{AVERAGE 1994 TRIP RATE} \times \text{COMPOSITE FACTOR} - \text{AVERAGE 1994 TRIP RATE}$$

$$\text{COMPOSITE FACTOR} = \frac{\text{1994 PERSON/VEH.}}{\text{2020 PERSON/VEH.}} \times \text{USAGE FACTOR} \times \frac{\text{2020 PERSON/DU}}{\text{1994 PERSON/DU}}$$

$$\text{COMPOSITE FACTOR} = \frac{1.38}{1.15} \times 0.95 \times \frac{2.40}{2.67} = 1.02$$

INCREASE FOR GENERATION RATES = (7.19 x 1.02) - 7.19 = 0.14

The trip generation rates for the 2020 were not increased.

Comparison With the Base Year

Table A-9 is a comparison of trips produced in the base year (1994) with trips produced in the design year (2020).

TABLE A-9

TRAVEL DATA SUMMARY		
TYPE	1994	2020
Average Daily Trips per DU	7.19	7.38
Internal Trips	67,876	94,644
Home Based Work	16,290	22,715
Other Home Based	35,296	49,215
Non-Home Based, internal	16,290	22,715
NHB secondary	16,400	32,760
Internal <-> External	51,138	96,060
Through Trips	48,816	92,650

Design year trip attraction factors for OHB and NHB purposes were determined by using the 1994 regression equation with projected 2020 zonal employment and dwelling unit data. Trip attraction factors for HBW trips were taken as the total projected zonal employment for the design year. The distribution of 2020 employment, as shown in Table A-5, was based on expected land use development as determined by the local officials. Design year internal and external-internal trips were again distributed by the gravity model.

TABLE A-10

Friction Factors
Henderson Planning Area

Time Interval	HBW	OHB	NHB	EXT-INT
1	11994	46529	15442	401068
2	14821	29547	25049	91022
3	14828	19968	23053	33046
4	12592	14180	13893	17471
5	9515	10447	6328	12243
6	6709	7884	2514	10353
7	4626	6018	1006	9615
8	3271	4587	468	8929
9	2487	3447	292	7546
10	2131	2521	282	5283
11	2157	1773	486	2789

TABLE A-11

Trip Length Frequency Distribution Curve
Henderson Area

Time Interval	HBW	OHB	NHB	EXT-INT
1	0.00	0.00	0.00	4.10
2	20.77	28.74	30.00	9.80
3	23.89	24.42	34.50	7.60
4	21.34	18.22	20.20	6.80
5	16.05	12.59	9.70	8.60
6	10.39	7.82	3.80	17.60
7	5.48	4.29	1.30	13.90
8	1.80	2.30	0.50	12.70
9	0.28	1.24	0.00	8.90
10	0.00	0.38	0.00	7.10
11	0.00	0.00	0.00	2.90
	100.00	100.00	100.00	100.00

APPENDIX B

GOALS & OBJECTIVES SURVEY DATA SUMMARY FOR HENDERSON

SURVEY FORM:

A two page survey was distributed to travellers in the planning area to determine local desires and priorities in the thoroughfare plan. The survey form was organized as follows:

Page 1: Twenty issues were scored from very undesirable (-2) to very desirable (+2) in the categories of Environment, Neighborhood, Economic, and Transportation.

Page 2: Five issues in each of five categories were ranked in order of importance (from 1-5, 1 being most important).

SUMMARY PROCEDURE:

The scores for each issue on page 1 were combined from all surveys to get totals (subtract negatives, add positives). These values were used in bar graph defining the priority of each issue.

For page 2, the number of times each issue received a #1 ranking was determined. These numbers were used in a bar graph to demonstrate which issues were most frequently ranked first.

CONCLUSIONS:

Responses recorded on page 1 of the survey indicate a strong desire for the following issues: 1) minimize travel time and cost in the planning area, 2) minimize roadway construction costs, 3) increase traffic safety, 4) protect local neighborhoods from truck traffic.

On page 2 the highest frequency of #1 rankings occurred in issues stating the need for an adequate loop facility and the desire to enhance the community.

GOALS & OBJECTIVES SURVEY
HENDERSON

Circle the number to indicate how desirable the following items are to you.

Very Undesirable ---	-2
Undesirable --------	-1
Neutral ----------	N
Desirable ----------	+1
Very Desirable -----	+2

ENVIRONMENTAL ISSUES:

1) Minimize air pollution from vehicles:	-2	-1	N	+1	+2
2) Minimize traffic noise in neighborhoods:	-2	-1	N	+1	+2
3) Minimize traffic noise in business areas:	-2	-1	N	+1	+2
4) Urbanize all undeveloped land:	-2	-1	N	+1	+2
5) Protect natural areas as buffer zones:	-2	-1	N	+1	+2

NEIGHBORHOOD ISSUES:

1) Preserve historic property:	-2	-1	N	+1	+2
2) Protect neighborhoods from truck traffic:	-2	-1	N	+1	+2
3) Landscape streets with trees and shrubs:	-2	-1	N	+1	+2
4) Invite long sections of urban strip development:	-2	-1	N	+1	+2
5) Preserve community character:	-2	-1	N	+1	+2

ECONOMIC ISSUES:

1) Minimize road construction costs:	-2	-1	N	+1	+2
2) Minimize travel time and cost:	-2	-1	N	+1	+2
3) Access downtown from I-85	-2	-1	N	+1	+2
4) Access downtown from US 1 Bypass:	-2	-1	N	+1	+2
5) Increase the local population:	-2	-1	N	+1	+2

TRANSPORTATION ISSUES:

1) Have frequent traffic signals on major roads:	-2	-1	N	+1	+2
2) Increase traffic safety:	-2	-1	N	+1	+2
3) Provide bicycle paths to schools and parks:	-2	-1	N	+1	+2
4) Provide vans to shopping areas and downtown to relieve some of the parking demand:	-2	-1	N	+1	+2
5) Provide sidewalks and scenic paths to encourage people to walk instead of drive:	-2	-1	N	+1	+2

GOALS & OBJECTIVES SURVEY
HENDERSON

Please rank each group of items in order of importance.
(1 is the most important, 5 is the least important)

RANK HOW ROAD CAPACITY SHOULD BE INCREASED:

_____ By improving the geometric design of intersections:
_____ By constructing additional traffic lanes:
_____ By controlling strip development and promoting campus developments:
_____ By encouraging people to ride together or ride public transportation:
_____ By providing alternative modes of travel such as pedestrian paths or bicycle trails:

RANK WHY ROADS SHOULD BE PLANNED:

_____ To urbanize the rural land outside the town limits:
_____ To increase the tax base:
_____ To control growth:
_____ To revitalize the existing developed areas (such as renovating historic buildings):
_____ To provide citizens knowledge of public intent:

RANK THE LOCAL ISSUES:

_____ Minimize road widening and construction costs:
_____ Construct an adequate loop facility:
_____ Minimize travel time from I-85 to downtown:
_____ Minimize travel time from US 1 Bypass to downtown:
_____ Attract new industry:

RANK THE ISSUES IN DEVELOPING A THOROUGHFARE PLAN:

_____ Environmental preservation:
_____ Individual home or business preservation:
_____ Community preservation:
_____ New economic development growth:
_____ Community enhancements (such as better roads, quieter neighborhoods, pedestrian trails...):

RANK LOCAL PROJECT NEEDS:

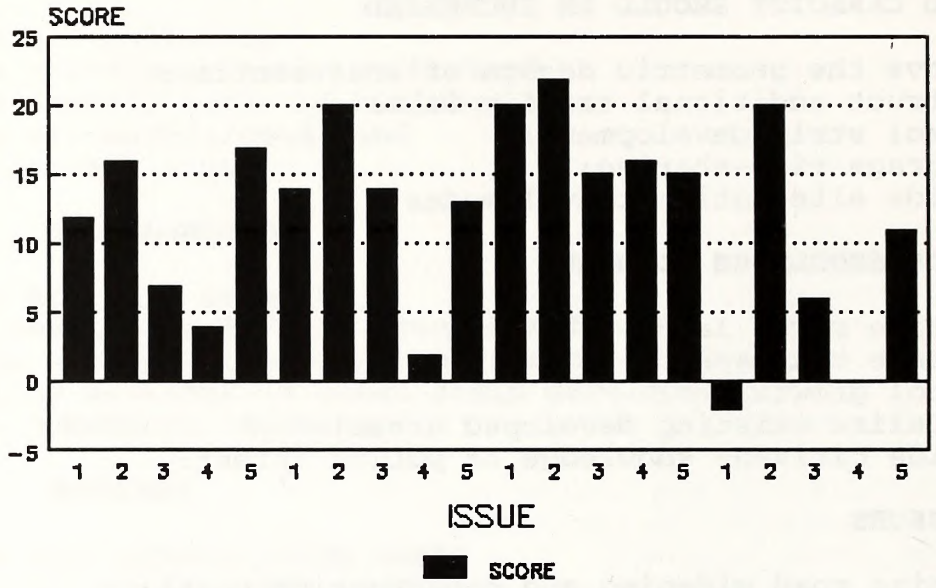
_____ Dabney Drive and Beckford Drive intersection:
_____ Dabney Drive and Garnett Street intersection:
_____ Right-of-way acquisition for the proposed loop systems:
_____

COMMENTS:

ISSUE	SCORE
ENVIRONMENTAL	
1) Minimize air pollution	12
2) Minimize traffic noise in neiborhood	16
3) Minimize traffic noise in business area	7
4) Urbanize all undeveloped land	4
5) protect natural areas	17
NEIGHBORHOOD	
1) Preserve historic property	14
2) Protect neighborhoods from truck traffic	20
3) Landscape streets with trees and shrubs	14
4) Invite long sections of urban strip development	2
5) Preserve community character	13
ECONOMIC	
1) Minimize road construction costs	20
2) Minimize travel time and cost	22
3) Access downtown from I-85	15
4) Access downtown from US 1 Bypass	16
5) Increase the local population	15
TRANSPORTATION	
1) Frequent traffic signals on major roads	-2
2) Increase traffic safety	20
3) Provide bicycle paths to schools and parks	6
4) Provide vans to shopping areas and downtown	0
5) Provide sidewalks and scenic paths	11

ISSUE/METHOD	FREQUENCY OF #1 RANKINGS
HOW ROAD CAPACITY SHOULD BE INCREASED	
1) Improve the geometric design of intersections:	5
2) Construct additional traffic lanes:	8
3) Control strip development:	0
4) Encourage ride-sharing:	1
5) Provide alternative travel modes:	0
WHY ROADS SHOULD BE PLANNED	
1) Urbanize rural land	1
2) Increase tax base:	4
3) Control growth:	4
4) Revitalize existing developed areas:	2
5) Provide citizens knowledge of public intent:	2
LOCAL ISSUES	
1) Minimize road widening and construction costs:	2
2) Construct an adequate loop facility:	8
3) Minimize travel time from I-85 to downtown:	1
4) Minimize travel time from the US 1 Bypass to downtown:	1
5) Attract new industry:	4
ISSUES IN DEVELOPING A THOROUGHFARE PLAN	
1) Environmental preservation:	0
2) Individual home or business preservation:	1
3) Community preservation:	1
4) New economic development growth:	4
5) Community enhancements:	8
LOCAL PROJECT NEEDS	
1) Dabney Drive and Beckford Drive intersection:	1
2) Dabney Drive and Garnett Street intersection:	1
3) Right-of-way acquisition for the proposed loop systems:	9

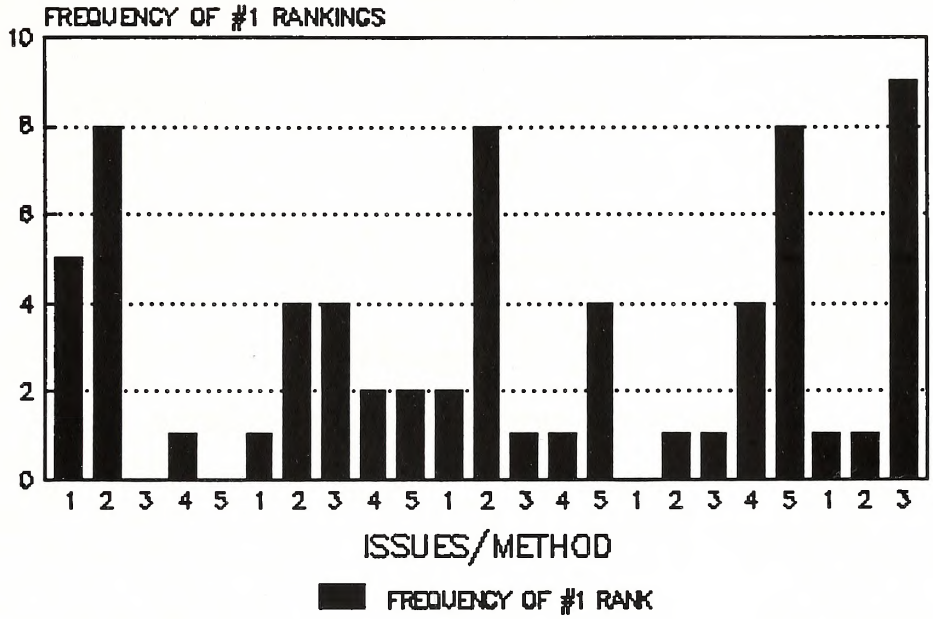
SURVEY PAGE 1
PRIORITY OF ISSUES



ISSUES AND SCORES LISTED ON PAGE B-4

SURVEY PAGE 2

ISSUES MOST FREQUENTLY RANKED #1



SEE ISSUES AND RANKINGS ON PAGE B-5

Appendix C

RECOMMENDED SUBDIVISION ORDINANCES

Note: English equivalents are printed in this report merely as a guide. The English measurements were not meant to represent exact conversions, and should not be used for standards, regulations, or construction. The tables in this section were taken from the Roadway Design Metric Design Manual. In the event of conflicting information, the Standard Specifications for Roads and Structures and the Roadway Design Metric Design Manual should serve as the standard.

Appendix C

RECOMMENDED SUBDIVISION ORDINANCES

DEFINITIONS

I. Streets and Roads

A. Rural Roads

1. Principal Arterial - A rural link in a highway system serving travel, and having characteristics indicative of substantial statewide or interstate travel and existing solely to serve traffic. This network would consist of Interstate routes and other routes designated as principal arterials.

2. Minor Arterial - A rural roadway joining cities and larger towns and providing intra-state and inter-county service at relatively high overall travel speeds with minimum interference to through movement.

3. Major Collector - A road which serves major intra-county travel corridors and traffic generators and provides access to the Arterial system.

4. Minor Collector - A road which provides service to small local communities and traffic generators and provides access to the Major Collector system.

5. Local Road - A road which serves primarily to provide access to adjacent land, over relatively short distances.

B. Urban Streets

1. Major Thoroughfares - Major thoroughfares consist of Inter-state, other freeway, expressway, or parkway roads, and major streets that provide for the expeditious movement of high volumes of traffic within and through urban areas.

2. Minor Thoroughfares - Minor thoroughfares perform the function of collecting traffic from local access streets and carrying it to the major thoroughfare system. Minor thoroughfares may be used to supplement the major thoroughfare system by facilitating minor through traffic movements and may also serve abutting property.

3. Local Street - A local street is any street not on a higher order urban system and serves primarily to provide direct access to abutting land.

C. Specific Type Rural or Urban Streets

1. Freeway, expressway, or parkway - Divided multilane roadways designed to carry large volumes of traffic at high speeds. A freeway provides for continuous flow of vehicles with no direct access to abutting property and with access to selected crossroads only by way of interchanges. An expressway is a facility with full or partial control of access and generally with grade separations at major intersections. A parkway is for non-commercial traffic, with full or partial control of access.

2. Residential Collector Street - A local street which serves as a connector street between local residential streets and the thoroughfare system. Residential collector streets typically collect traffic from 100 to 400 dwelling units.

3. Local Residential Street - Cul-de-sacs, loop streets less than 760 meters (2500 ft) in length, or streets less than 1.6 kilometers (1.0 miles) in length that do not connect thoroughfares, or serve major traffic generators, and do not collect traffic from more than 100 dwelling units.

4. Cul-de-sac - A short street having only one end open to traffic and the other end being permanently terminated and a vehicular turn-around provided.

5. Frontage Road - A road that is parallel to a partial or full access controlled facility and provides access to adjacent land.

6. Alley - A strip of land, owned publicly or privately, set aside primarily for vehicular service access to the back side of properties otherwise abutting on a street.

II. Property

A. Building Setback Line - A line parallel to the street in front of which no structure shall be erected.

B. Easement - A grant by the property owner for use by the public, a corporation, or person(s), of a strip of land for a specific purpose.

C. Lot - A portion of a subdivision, or any other parcel of land, which is intended as a unit for transfer of ownership or for development or both. The word "lot" includes the words "plat" and "parcel".

III. Subdivision

A. Subdivider - Any person, firm, corporation or official agent thereof, who subdivides of develops any land deemed to be a subdivision.

B. Subdivision - All divisions of a tract or parcel of land into two or more lots, building sites, or other divisions for the purpose, immediate or future, of sale or building development and all divisions of land involving the dedication of a new street or change in existing streets; provided, however, that the following shall not be included within this definition nor subject to these regulations: (1) the combination or re-combination of portions of previously platted lots where the total number of lots is not increased and the resultant lots are equal to or exceed the standards contained herein; (2) the division of land into parcels greater than 4 hectares (10 acres) where no street right-of-way dedication is involved, (3) the public acquisition, by purchase, of strips of land for the widening or the opening of streets; (4) the division of a tract in single ownership whose entire area is no greater than 0.8 hectares (2 acres) into not more than three lots, where no street right-of-way dedication is involved and where the resultant lots are equal to or exceed the standards contained herein.

C. Dedication - A gift, by the owner, of his property to another party without any consideration being given for the transfer. The dedication is made by written instrument and is completed with an acceptance.

D. Reservation - Reservation of land does not involve any transfer of property rights. It constitutes an obligation to keep property free from development for a stated period of time.

DESIGN STANDARDS

I. Streets and Roads

The design of all roads within the Planning Area shall be in accordance with the accepted policies of the North Carolina Department of Transportation, Division of Highways, as taken or modified from the American Association of State Highway Officials' (AASHTO) manuals.

The provision of street rights-of-way shall conform and meet the recommendations of the Thoroughfare Plan, as adopted by the municipality.

The proposed street layout shall be coordinated with the existing street system of the surrounding area. Normally the proposed streets should be the extension of existing streets if possible.

A. Right-of-way Widths - Right-of-way (ROW) widths shall not be less than the following and shall apply except in those cases where ROW requirements have been specifically set out in the Thoroughfare Plan.

	Min. ROW	
1. Rural		
a. Principle Arterial		
Freeways	105 m	(350 ft)
Other	60 m	(200 ft)
b. Minor Arterial	30 m	(100 ft)
c. Major Collector	30 m	(100 ft)
d. Minor Collector	24 m	(80 ft)
e. Local Road	18 m[1]	(60 ft)
2. Urban		
a. Major Thoroughfare other than Freeway and Expressway	27 m	(90 ft)
b. Minor Thoroughfare	21 m	(70 ft)
c. Local Street	18 m[1]	(60 ft)
d. Cul-de-sac	Variable[2]	

The subdivider will only be required to dedicate a maximum of 30 meters (100 ft) of right-of-way. In cases where over 30 meters (100 ft) of right-of-way is desired, the subdivider will be required only to reserve the amount in excess of 30 meters (100 ft). On all cases in which right-of-way is sought for a fully controlled access facility, the subdivider will only be required to make a reservation. It is strongly recommended that subdivisions provide access to properties from internal streets, and that direct property access to major thoroughfares, principle and minor arterials, and major collectors be avoided. Direct property access to minor thoroughfares is also undesirable.

A partial width right-of-way, not less than 18 meters (60 ft) in width, may be dedicated when

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[1] The desirable minimum right-of-way (ROW) is 18 meters (60 ft). If curb and gutter is provided, 15 meters (50 ft) of ROW is adequate on local residential streets.

[2] The ROW dimension will depend on radius used for vehicular turn around. Distance from edge of pavement of turn around to ROW should not be less than distance from edge of pavement to ROW on street approaching turn around.

adjoining undeveloped property that is owned or controlled by the subdivider; provided that the width of a partial dedication be such as to permit the installation of such facilities as may be necessary to serve abutting lots. When the said adjoining property is sub-divided, the remainder of the full required right-of-way shall be dedicated.

B. Street Widths - Widths for street and road classifications other than local shall be as recommended by the Thoroughfare Plan. Width of local roads and streets shall be as follows:

1. Local Residential
   Curb and Gutter section: 7.8 meters (26 ft), face to face of curb
   Shoulder section: 6.0 meters (20 ft) to edge of pavement, 1.2 meters (4 ft) for shoulders

2. Residential Collector
   Curb and Gutter section: 10.2 meters (34 ft), face to face of curb
   Shoulder section: 6.0 meters (20 ft) to edge of pavement, 1.8 meters (6 ft) for shoulders

C. Geometric Characteristics - The standards outlined below shall apply to all subdivision streets proposed for addition to the State Highway System or Municipal Street System. In cases where a subdivision is sought adjacent to a proposed thoroughfare corridor, the requirements of dedication and reservation discussed under Right-of-Way shall apply.

1. Design Speed - The design speed for a roadway should be a minimum of 10 km/h (5 mph) greater than the posted speed limit. The design speeds for subdivision type streets shall be:

DESIGN SPEEDS (METRIC)			
Facility Type	Design Speed km/h Desirable	Minimum Level	Rolling
RURAL			
Minor Collector Roads (ADT Over 2000)	100	80	60
Local roads including Residential Collectors and Local Residential (ADT Over 400)	80	80	60
URBAN			
Major Thoroughfares other than Freeway or Expressway	100	60	60
Minor Thoroughfares	100	50	50
Local Streets	50	50	30

DESIGN SPEEDS (ENGLISH)			
Facility Type	Design Speed mph Desirable	Minimum Level	Rolling
RURAL			
Minor Collector Roads (ADT Over 2000)	60	50	40
Local roads including Residential Collectors and Local Residential (ADT Over 400)	50	* 50	* 40
URBAN			
Major Thoroughfares other than Freeway or Expressway	60	50	40
Minor Thoroughfares	40	30	30
Local Streets	30	**30	**20

* Based on ADT of 400-750. Where roads serve a limited area and small number of units, can reduce min design speed.

**Based on projected ADT of 50-250.
(Reference NCDOT Roadway Design Manual page 1-1B)

2. Maximum and Minimum Grades

a. The maximum grades in percent shall be:

MAXIMUM VERTICAL GRADE (METRIC)				
Facility Type	Design Speed (km/h)	Maximum Grade (Percent) Flat	Rolling	Mountainous
RURAL				
Minor Collector Roads*	30	7	10	12
	50	7	9	10
	65	7	8	10
	80	6	7	9
	100	5	6	8
	110	4	5	6
Local roads including Residential Collectors and Local Residential Streets*	30	-	11	16
	50	7	10	14
	65	7	9	12
	80	6	8	10
	100	5	6	-
URBAN				
Major Thoroughfares other than Freeway or Expressway	50	8	9	11
	65	7	8	10
	80	6	7	9
	100	5	6	8
Minor Thoroughfares*	30	9	12	14
	50	9	11	12
	65	9	10	12
	80	7	8	10
	100	6	7	9
	110	5	6	7
Local Streets*	30	-	11	16
	50	7	10	14
	65	7	9	12
	80	6	8	10
	100	5	6	-

* For streets and roads with projected annual average daily traffic less than 250 or short grades less than 150 meters (500 ft) long, grades may be 2% steeper than the values in the above table.

(Reference NCDOT Roadway Metric Design Manual page 1-12 T-3)

MAXIMUM VERTICAL GRADE (ENGLISH)				
Facility Type	Design Speed (mph)	Maximum Grade (Percent) Flat	Rolling	Mountainous
RURAL				
Minor Collector Roads*	20	7	10	12
	30	7	9	10
	40	7	8	10
	50	6	7	9
	60	5	6	8
	70	4	5	6
Local roads including Residential Collectors and Local Residential Streets*	20	-	11	16
	30	7	10	14
	40	7	9	12
	50	6	8	10
	60	5	6	-
URBAN				
Major Thoroughfares other than Freeway or Expressway	30	8	9	11
	40	7	8	10
	50	6	7	9
	60	5	6	8
Minor Thoroughfares*	20	9	12	14
	30	9	11	12
	40	9	10	12
	50	7	8	10
	60	6	7	9
	70	5	6	7
Local Streets*	20	-	11	16
	30	7	10	14
	40	7	9	12
	50	6	8	10
	60	5	6	-

b. Minimum grade should not be less than 0.5% .

c. Grades for 30 meters (100 ft) each way from intersections (measured from edge of pavement) should not exceed 5%.

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* For streets and roads with projected annual average daily traffic less than 250 or short grades less than 150 meters (500 ft) long, grades may be 2% steeper than the values in the above table.

(Reference NCDOT Roadway Design Manual page 1-12 T-3)

3. Minimum Sight Distance - In the interest of public safety, no less than the minimum sight distance applicable shall be provided. Vertical curves that connect each change in grade shall be provided and calculated using the following parameters:

SIGHT DISTANCE (METRIC)					
Design Speed (km/h)	30	50	60	90	100
Stopping Sight Distance					
Minimum (meters)	29.6	57.4	74.3	131.2	157.0
Desirable (meters)	30	70	90	170	210
Minimum K* Value for:					
Crest curve	3	9	14	43	62
Sag curve	4	11	15	30	37
Passing Sight Distance:					
Minimum Passing Dist for two lanes, in m	*	*	*	*	*

(General practice calls for vertical curves to be multiples of 10 meters. Calculated lengths shall be rounded up in each case.)
* Currently under revision.
(Reference NCDOT Roadway Metric Design Manual page 1-12 T-1)

SIGHT DISTANCE (ENGLISH)				
Design Speed, MPH	30	40	50	60
Stopping Sight Distance:				
Minimum (ft.)	200	275	400	525
Desirable (ft.)	200	325	475	650
Minimum K* Value for:				
Crest Curve	30	60	110	190
Sag Curve	40	60	90	120
Passing Sight Distance:				
Minimum Passing Distance for 2 lanes, in feet	1,100	1,500	1,800	2,100

(General practice calls for vertical curves to be multiples of 50 feet. Calculated lengths shall be rounded up in each case.)
(Reference NCDOT Roadway Design Manual page 1-12 T-1)

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* K is a coefficient by which the algebraic difference in grade may be multiplied to determine the length of the vertical curve which will provide the desired sight distance. Sight distance provided for stopped vehicles at intersections should be in accordance with "A Policy on Geometric Design of Highways and Streets, 1990".

4. The "Superelevation Table" shown below shows the minimum radius and the related maximum superelevation for design speeds. The maximum rate of roadway superelevation (e) for rural roads with no curb and gutter is 0.08. The maximum rate of superelevation for urban streets with curb and gutter is 0.06, with 0.04 being desirable.

SUPERELEVATION TABLE (METRIC)		
Design Speed	Maximum e*	Minimum Radius m
50 km/h	0.04	100
65	0.04	175
80	0.04	280
100	0.04	490
50	0.06	90
65	0.06	160
80	0.06	250
100	0.06	435
50	0.08	80
65	0.08	145
80	0.08	230
100	0.08	395

e = rate of roadway superelevation, meter per meter

SUPERELEVATION TABLE (ENGLISH)			
Design Speed	Maximum e*	Minimum Radius ft.	Max. Deg. of Curve
30 mph	0.04	302	19 00′
40	0.04	573	10 00′
50	0.04	955	6 00′
60	0.04	1,637	3 45′
30	0.06	273	21 00′
40	0.06	521	11 15′
50	0.06	955	6 45
60	0.06	1,432	4 15′
30	0.08	260	22 45′
40	0.08	477	12 15′
50	0.08	819	7 30′
60	0.08	1,146	4 45′

* e = rate of roadway superelevation, foot per foot
(Reference NCDOT Roadway Design Manual page 1-12 T-6 thru T-8)

D. Intersections

1. Streets shall be laid out so as to intersect as nearly as possible at right angles, and no street should intersect any other street at an angle less than sixty-five (65) degrees.

2. Property lines at intersections should be set so that the distance from the edge of pavement, of the street turnout, to the property line will be at least as great as the distance from the edge of pavement to the property line along the intersecting streets. This property line can be established as a radius or as a sight triangle. Greater offsets from the edge of pavement to the property lines will be required, if necessary, to provide sight distance for the stopped vehicle on the side street.

3. Off-set intersections are to be avoided. Intersections which cannot be aligned should be separated by a minimum length of 60 meters (200 ft) between survey center lines.

E. Cul-de-sacs

Cul-de-sacs shall not be more than 150 meters (500 ft) in length. The distance from the edge of pavement on the vehicular turn around to the right-of-way line should not be less than the distance from the edge of pavement to right-of-way line on the street approaching the turn around. Cul-de-sacs should not be used to avoid connection with an existing street or to avoid the extension of an important street.

F. Alleys

1. Alleys shall be required to serve lots used for commercial and industrial purposes except that this requirement may be waived where other definite and assured provisions are made for service access. Alleys shall not be provided in residential subdivisions unless necessitated by unusual circumstances.

2. The width of an alley shall be at least 6.0 meters (20 ft).

3. Dead end alleys shall be avoided where possible, but if unavoidable, shall be provided with adequate turn around facilities at the dead end as may be required by the Planning Board.

G. Permits For Connection To State Roads

An approved permit is required for connection to any existing state system road. This permit is required prior to any construction on the street or road. The application is

available at the office of the District Engineer of the Division of Highways.

H. Offsets To Utility Poles

Poles for overhead utilities should be located clear of roadway shoulders, preferably a minimum of at least 9.0 meters (30 ft) from the edge of pavement. On streets with curb and gutter, utility poles shall be set back a minimum distance of 1.8 meters (6 ft) from the face of curb.

I. Wheel Chair Ramps

All street curbs being constructed or reconstructed for maintenance purposes, traffic operations, repairs, correction of utilities, or altered for any reason, shall provide wheelchair ramps for the physically handicapped at intersections where both curb and gutter and sidewalks are provided and at other major points of pedestrian flow.

J. Horizontal Width on Bridge Deck

1. The clear roadway widths for new and reconstructed bridges serving 2 lane, 2 way traffic should be as follows:

a. Shoulder section approach

i. Under 800 ADT design year

Minimum 8.4 meters (28 ft) width face to face of parapets, rails, or pavement width plus 3.0 meters (10 ft), whichever is greater.

ii. 800 - 2000 ADT design year

Minimum 10.2 meters (34 ft) width face to face of parapets, rails, or pavement width plus 3.6 meters (12 ft), whichever is greater.

iii. Over 2000 ADT design year

Minimum width of 12 meters (40 ft), desirable width of 13.2 meters (44 ft) width face to face of parapets or rails.

b. Curb and gutter approach

i. Under 800 ADT design year

Minimum 7.2 meters (24 ft) face to face of curbs.

ii. Over 800 ADT design year

Width of approach pavement measured face to face of curbs.

Where curb and gutter sections are used on roadway approaches, curbs on bridges shall match the curbs on approaches in height, in width of face to face of curbs, and in crown drop. The distance from face of curb to face of parapet or rail shall be a minimum of 450 millimeters (1′ 6"), or greater if sidewalks are required.

2. The clear roadway widths for new and reconstructed bridges having 4 or more lanes serving undivided two-way traffic should be as follows:

   a. Shoulder section approach - Width of approach pavement plus width of usable shoulders on the approach left and right. (Shoulder width 2.4 m (8 ft) minimum, 3.0 m (10 ft) desirable.)

   b. Curb and gutter approach - Width of approach pavement measured face to face of curbs.

APPENDIX D

STREET TABULATION FOR

HENDERSON PLANNING AREA

The Street Tabulation consists of major and minor thoroughfares with base year and future year traffic volumes, and the recommended cross section for each road.

Definitions

DIST MI:	Section length in miles
RDWY FT:	Roadway width in feet
ROW FT:	Right-of-Way in feet
Capacity:	Capacity at Level of Service D
2020 ADT:	Avarage Daily Traffic (2020) on Thoroughfare Plan system
PAB:	Planning Area Boundry
ADQ:	Adequate
ULT	Ultimate

APPENDIX D

TABLE D-1 THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS

FACILITY AND SECTION	EXISTING CROSS SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1994 ADT	2020 ADT	RECOMMENDED CROSS SECTION RDWY (ULT)	ROW (ULT)
Abbott Road (SR 1547):								
South PAB-Bear Pond Rd.	1.70	20	60	10500	800	2500	(K)	ADQ
Alexander Avenue:								
Nicholas St.-Harriet	0.60	38	50	11000	3100	5900	(H)	(60)
Harriet St.-Elm St.	0.08	20	50	9500	3100	5900	(H)	(60)
Elm St.-Pinkston St.	0.10	20	50	9500	3100	5900	(H)	(60)
Alexander Ave. Extension:								
Pinkston St.-Jane Ave	0.34	-	-	(12000)	-	6300	(H)	60
Andrews Avenue:								
See NC 39	-	-	-	-	-	-	-	-
Bear Pond Road & North Lynnbank Road (SR 1115):								
SR 1519-US 1 Bypass	1.70	20	60	9500	2200	6000	(K)	ADQ
US 1 Bypass-US 1 Business	0.45	20	60	9500	2800	5300	(K)	ADQ
US 1 Business-Edwards Rd.	0.95	20	60	9500	1200	3300	(K)	ADQ
Edwards Rd.-South PAB	2.85	20	60	9500	1100	2500	(K)	ADQ
Beckford Drive (SR 1165):								
US 1/158 Bus.-NC 39	0.80	52	80	20000	6000	13000	C	ADQ
NC 39-Parrish Mill Rd.	0.30	49	80	18000	9000	16900	C	ADQ
Parrish Mill Rd.-Roanoke	0.35	25	80	12000	10000	18000	C	ADQ
Roanoke Ave.-Lows Shop	0.75	25	80	12000	6500	12000	C	ADQ
Lows Shop-Dabney Drive	0.20	52	80	20000	6500	12000	C	ADQ
Belle Street:								
Parham St.-Dorsey Ave.	0.50	20	60	8500	-	-	(J)	ADQ
Belle Street Extension:								
Dorsey Ave.-Chavasse Ave.	0.08	-	-	-	-	-	(J)	60
Bellwood Drive:								
Cypress Dr.-Oxford Rd.	0.30	40	60	10000	1000	3200	ADQ	ADQ
Belmont Drive & County Home Road (SR 1101):								
Raleigh Rd.-Brodie St.	0.40	20	60	10500	4500	13400	G	70
Browdie Street - Future Western Outer Loop	0.90	20	60	10500	4000	14600	G	70
Future Western Outer Loop-Vance Academy Road	0.30	20	60	10500	3200	6700	(K)	ADQ
Vance Academy-Lynnbank Rd.	2.00	20	60	10500	1200	4800	(K)	ADQ
Brodie Street:								
Oxford Rd.-Belmont Dr.	1.40	18	60	8000	2100	4000	(k)	ADQ
Brookstone Rd.(SR 1507):								
SR 1001-US 1/158 Bus.	1.75	18	60	8000	1200	2600	(K)	ADQ

APPENDIX D

TABLE D-1 THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS

FACILITY AND SECTION	EXISTING CROSS SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1994 ADT	2020 ADT	RECOMMENDED CROSS SECTION RDWY (ULT)	ROW (ULT)
Carver School Road, SR 1505:								
SR 1507-East PAB	0.40	18	60	8000	950	1900	ADQ	ADQ
Chavasse Ave.:								
Raleigh Rd.-William St.	0.30	18	60	8000	6100	10800	H	ADQ
William St.-College St.	0.20	44	60	12000	6100	10800	H	ADQ
College St.-Arch St.	0.10	18	60	8000	6100	10800	H	ADQ
Chestnut Street:								
Corbitt Rd.-Jennette Ave.	0.20	30	65	12000	5000	9500	ADQ	ADQ
Jennette Ave.-Granite St.	0.10	36	65	12000	5300	9800	ADQ	ADQ
Granite St.-Spring St.	0.20	36	70	12000	5600	9900	ADQ	ADQ
Spring St.-Orange St.	0.10	46	75	12000	5800	9900	ADQ	ADQ
Orange St.-Montgomery St	0.20	51	80	14000	6000	10200	ADQ	ADQ
Montgomery St.-Young St.	0.05	46	55	14000	6100	10300	ADQ	ADQ
Young St.-NC 39	0.20	40	58	12000	6800	10500	ADQ	ADQ
NC 39-Rockspring St.	0.20	40	55	12000	5400	9100	ADQ	ADQ
Rockspring St.-US 1 Bus.	0.40	40	55	12000	5200	9000	ADQ	ADQ
Cypress Drive:								
Dabney Dr.-Summit Rd.	0.60	22	60	9000	1100	2200	ADQ	ADQ
Corbitt Road:								
Garnett St.-Parham St.	0.70	18	60	8000	2500	5100	(H)	ADQ
Dabney Drive (SR 1162):								
Ruin Creek Rd. -US 158 BY	0.25	24	60	11000	4600	9000	(C)	90
US 158 BYPASS - I-85	0.30	50	60	22000	10600	14700	(C)	90
I-85 - Coble Blvd.	0.37	50	80	22000	19700	21000	(C)	90
Coble Blvd.-Oakdale Cir.	0.26	40	60	16000	17000	19000	(C)	90
Oakdale Cir.-Oxford Rd.	1.10	40	55	16000	15300	17000	(C)	90
Oxford Rd.-Raleigh Rd.	0.30	52	80	24000	6600	10000	ADQ	ADQ
Dabney Road & Hicks Road (SR1303):								
Ruin Creek Rd.-North PAB	3.40	18	60	8000	4000	6000	(K)	ADQ
Dabney Rd. (SR 1304):								
SR 1303-West PAB	2.85	18	60	8000	1000	2500	(K)	ADQ
Dorsey Avenue:								
Dabney Dr.-Young Ave.	0.40	18	60	8000	4200	6800	(H)	ADQ
East Avenue Extension: (US 1 Bypass Service Rd.)								
East Ave.-John Deere Rd.	1.90	-	-	(12000)	-	3200	(K)	70
Edwards Road (SR 1114):								
South PAB-Lynnbank Rd.	1.70	18	60	8000	350	4400	K	ADQ

APPENDIX D

TABLE D-1 THOROUGHFARE PLAN STREET TABULATION AND RECOMMENDATIONS

FACILITY AND SECTION	EXISTING CROSS SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1994 ADT	2020 ADT	RECOMMENDED CROSS SECTION RDWY (ULT)	ROW (ULT)
Epsom Rd./Vanco Mill Rd:								
NC 39-US 1 Bypass	0.90	20	60	9000	2600	5000	(K)	ADQ
US 1 Bypass-Skenes Ave.	0.90	20	60	9000	4300	7800	(H)	ADQ
Skenes Ave.-Nicholas St.	0.60	20	60	9000	3400	6400	(H)	ADQ
Flint Street:								
Arch St.-Winder St.	0.30	18	60	8000	2000	4900	(H)	ADQ
Faulkner Town Rd(SR 1541):								
Rock Mill Rd.-East PAB	1.80	18	60	8000	400	1000	(K)	ADQ
Garrett Road (SR 1538):								
US 1 Bypass-SR 1519	1.40	22	60	11000	2100	5200	(K)	ADQ
Garnett Street:								
Wiggins St.-Andrews Ave.	0.60	50	60	12000	8500	16400	G	70
Andrews Ave.-Young St.	0.20	50	60	16000	11000	19000	G	70
Young St.-Montgomery St.	0.10	50	60	16000	11000	19000	G	70
Montgomery-Breckenridge	0.10	50	60	16000	11000	19000	G	70
Breckenridge St.-Winder	0.10	50	60	16000	12900	21600	G	70
Winder St.-Horner St.	0.10	50	60	16000	12900	21600	G	70
Horner St.-Spring St.	0.10	50	60	16000	12800	22000	G	70
Spring St.-Burwell Ave.	0.10	50	60	16000	12700	21900	G	70
Burwell Ave.-Belle St.	0.10	50	60	16000	12800	21500	G	70
Belle St.-Raleigh Rd.	0.10	50	60	16000	12900	21500	G	70
Raleigh Rd.-Jennette St.	0.10	30	60	12000	9800	18000	G	70
Jennette St.-Corbitt Rd.	0.10	30	60	12000	8900	16900	G	70
Corbitt Rd.-Dabney Dr.	0.05	30	60	16000	8200	15800	G	70
Graham Avenue (SR 1218):								
Ruin Creek Rd.-Dabney Dr.	1.12	24	100	12000	4100	8800	(H)	ADQ
I-85:								
North PAB-NC 39	4.50	56	240	54000	23100	49000	ADQ	ADQ
NC 39-US 158 Bypass	1.10	56	240	54000	29000	51900	ADQ	ADQ
US 158 Bypass-Dabney Dr.	0.66	56	240	54000	24500	44800	ADQ	ADQ
Dabney Dr.-West PAB	3.80	56	240	54000	26800	53000	ADQ	ADQ
Jane Avenue:								
NC 39-Alexander Ave. Ext.	0.50	20	60	8500	500	2300	ADQ	ADQ
John Deere Rd. Extension:								
John Deere Rd.-East Ave.	1.90	-	-	(12000)	-	3200	(K)	70
J.P.Taylor Road(SR 1139):								
Raleigh Rd.-Epsom Rd.	1.20	24	60	10000	4400	7400	(H)	ADQ
Kelly Road (SR 1326):								
Hicks Rd.-North PAB	1.70	18	60	8000	900	2300	(K)	ADQ
King Street & Extension:								
Feilds Av. Ext-Welcome Av.	0.47	18	60	8000	1000	3800	(H)	ADQ

APPENDIX D

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Main Street (SR 1554):								
US 1 Business-David St.	0.30	18	35	8000	3000	6500	(H)	60
Main Street Extension:								
David St.-Pinkston St Ext.	0.27	-	-	(12000)	-	7200	H	60
Pinkston St. Extension - East Ave. Extension	0.40	-	-	(12000)	-	2100	H	60
McArthur St. & Fuller St. Extension:								
McArthur St. Dead End - Epsom Rd. @ Fuller St.	0.28	-	-	(12000)	-	9800	H	60
Fuller St. Dead End - J.P. Taylor Rd.	0.40	-	-	(12000)	-	4500	H	60
Merriman Street Extension:								
Merriman St.-Beckford Dr.	0.16	-	-	(12000)	-	5600	H	60
Montgomery Street:								
Garnett St.-Young Street	0.40	22	40	9000	-	-	(H)	60
Montgomery St. Extension:								
Young Street-Parkway Dr.	0.10	-	-	(12000)	-	-	H	60
Newton Dairy Road & Water Street (SR 1518):								
NC 39-Pinkston St.	0.50	26	60	10000	3400	7500	(H)	ADQ
Pinkston St.-SR 1519	1.70	20	60	9000	2600	4200	(K)	ADQ
SR 1519-East PAB	1.20	20	60	9000	900	1760	ADQ	ADQ
NC 39 (Andrews Avenue):								
North PAB-Omega Rd.	2.93	24	100	11000	4500	10400	G	ADQ
Omega Rd.-Chestnut St.	1.40	52	100	22000	12500	18700	G	ADQ
Chestnut St.-Garnett St.	0.20	38	60	16000	12500	18700	G	70
Garnett St.-Rowland St.	0.20	38	60	16000	12600	18900	G	70
Rowland St.-Highland St.	0.10	38	60	16000	13100	19100	G	70
Highland St.-Water St.	0.10	38	62	16000	13200	19200	G	70
Water St.-Vance St.	0.10	39	45	16000	13100	19000	G	70
Vance St.-Pinkston St.	0.40	30	50	16000	13300	19300	G	70
Pinkston St.-US 1 Bypass	0.50	40	65	16000	14800	20800	G	70
US 1 Bypass-Viksboro Rd.	0.50	42	60	22000	11400	17000	G	70
Vicksboro Rd.-Vanco Mill	2.10	22	60	10000	6800	13200	G	70
Vanco Mill Rd.-South PAB	2.65	22	60	10000	6000	13200	G	70
Nicholas Street & Saint Mathews St (SR 1143):								
Chavasse Ave.-Williams Av.	0.25	30	55	12000	6900	8900	ADQ	ADQ
Williams St-Alexander Av.	0.08	30	55	12000	6400	8200	ADQ	ADQ
Alexander Ave.-Wilkins Av.	0.58	20	55	8500	3400	5400	(H)	70
Wilkins Ave.-Welcome Ave.	0.54	20	55	8500	2000	4600	(H)	70

APPENDIX D

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FACILITY AND SECTION	EXISTING CROSS SECTION DIST MI	RDWY FT	ROW FT	CAPACITY CURRENT (FUTURE)	1994 ADT	2020 ADT	RECOMMENDED CROSS SECTION RDWY (ULT)	ROW (ULT)
Orange Street:								
Garnett St.-Parham St.	0.35	30	60	11000	1400	3900	ADQ	ADQ
Parham St.-Cross St.	0.15	18	60	8000	1400	3900	ADQ	ADQ
Oxford Road:								
See US 158 Business	-	-	-	-	-	-	-	-
Parham Street:								
Dabney Dr.-Young Ave.	0.70	36	40	10000	2750	3600	ADQ	ADQ
Young Ave.- Spring St.								
Spring St.- Orange St.								
Peter Gill Rd (SR 1548):								
US 1 Business-Bear Pond	2.10	20	60	8500	980	1700	(K)	ADQ
Pinkston Street (SR 1214):								
Mill St.-Water St.	0.20	20	50	8500	1000	10800	(G)	60
Water St.-NC 39	0.40	20	50	8500	2300	11500	(G)	60
NC 39-Alexander Ave.	0.60	20	50	8500	5400	9200	(G)	60
Alexander Ave.-Victory St.	0.30	20	50	8500	3700	6500	(G)	60
Pinkston St. Extension:								
Mill St.-Main St. Ext.	0.37	-	-	(12000)	-	11800	G	60
Main St. Ext.-Spring Vally	1.00	-	-	(12000)	-	9200	G	60
Poplar Creek Rd.(SR 1126):								
US 158 Business-SR 1304	3.10	18	60	8000	1200	3800	(K)	ADQ
Poplar Street:								
Parkway Dr.-Poplar St.	0.20	18	30	8000	-	-	(H)	(60)
Poplar Street Extension:								
Poplar St.-Beckford Dr.	0.10	-	-	(12000)	-	-	H	60
Raleigh Road:								
See US 1 Business	-	-	-	-	-	-	-	-
Roanoke Avenue (SR 1163):								
Dabney Dr.-Abbott St.	0.40	32	50	12000	1300	3200	ADQ	ADQ
Abbott St.-Beckford Drive	0.20	24	50	10000	1300	3200	ADQ	ADQ
Rock Mill Road, Gillburg Road & Carey Chappel Road (SR 1519):								
South PAB-NC 39	1.60	18	60	8000	700	1600	(K)	ADQ
NC 39-Vicksboro Rd.	2.85	18	60	8000	2100	4500	(K)	ADQ
Vicksboro Rd.-SR 1001	1.80	18	60	8000	2100	4800	(K)	ADQ

APPENDIX D

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Ruin Creek Road (SR 1128):								
US 158 Bus. - I-85	1.80	24	60	10000	2900	6000	ADQ	ADQ
I-85 - SR 1303	0.80	20	60	8500	3900	8900	(K)	ADQ
Saint Andrews Church Road (SR 1309):								
NC 39-SR 1303	1.90	18	60	8000	700	2300	(K)	ADQ
Satterwhite Point Road (SR 1319):								
North PAB - I-85	1.50	24	60	10000	2100	4500	ADQ	ADQ
I-85 - US 1 Business	0.65	24	60	10000	4300	4870	ADQ	ADQ
South Lake Lodge Road (SR 1113):								
South PAB-N. Lynnbank Rd.	0.85	20	60	8500	175	560	ADQ	ADQ
Spring Valley Lake Road, (SR 1318):								
North PAB-Spring Valley Rd	1.70	18	60	8000	600	1400	(K)	ADQ
Spring Valley Road, (SR 1317):								
NC 39-SR 1318	2.00	18	60	8000	1050	4500	(K)	ADQ
SR 1318-US 158 Business	0.75	18	60	8000	1900	6200	(K)	ADQ
Thorpe Street (SR 1161):								
Oxford Rd.-Lynn Haven Av.	0.20	18	60	8000	300	1400	(H)	ADQ
Thorpe St. Extension:								
Lynn Haven Ave.-Miriam St.	0.75	-	-	(10000)		1400	H	60
US 1 BUS. (Raleigh Rd.):								
South PAB-US 1 Bypass	1.98	20	100	9000	2950	6600	C	ADQ
US 1 Bypass-Welcome Ave.	2.00	20	100	9000	9800	19800	C	ADQ
Welcome Ave.-Garnett St.	1.50	24	100	12000	11000	19000	C	ADQ
Garnett St.-Wiggins St. (See Garnett Street)	-	-	-	-	-	-	-	-
US 1 Bypass:								
I-85 - Warrenton Road	1.50	48	260	40000	4500	12000	ADQ	ADQ
Warrenton Rd.-NC 39	2.40	48	260	40000	6400	13000	ADQ	ADQ
NC 39-Epsom Rd.	1.50	48	260	40000	8000	16500	ADQ	ADQ
Epsom Rd.-Bear Pond Rd.	1.70	48	260	40000	5100	12300	ADQ	ADQ
Bear Pond Rd.-US 1 BUS.	0.56	48	260	40000	4000	10000	ADQ	ADQ
US 1 BUS.-South PAB	2.10	48	260	40000	6600	15000	ADQ	ADQ
US 1/US 158 Bypass								
North PAB-US 1/US 158 BuS	1.51	24	100	12000	4500	9000	ADQ	ADQ

APPENDIX D

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US 158 BUS. (Oxford Rd.):								
West PAB-SR 1128	2.30	20	60	8500	3000	7000	(K)	ADQ
SR 1128-Crest Rd.	1.70	20	60	8500	3500	7700	(K)	ADQ
Crest Rd.-Cedarwood Dr.	0.90	40	65	20000	4500	8000	ADQ	ADQ
Cedarwood Dr.-Willowood	0.30	44	65	20000	4500	9000	ADQ	ADQ
Willowood Dr.-Dabney Dr.	0.40	44	65	20000	6000	9500	ADQ	ADQ
US 158 Bypass:								
West PAB - SR 1128	3.20	24	200	12000	5700	10000	ADQ	ADQ
SR 1128 - I-85	1.20	48	200	22000	10000	17000	ADQ	ADQ
US 158 & US 1 Business:								
US 1 Bypass-Warrenton Rd.	1.42	48	100	22000	3900	9600	ADQ	ADQ
Warrenton Rd.-Chessnut St	1.40	48	100	22000	13800	21800	ADQ	ADQ
Vance Academy Road (SR 1120):								
Oxford Rd.-SR 1101	1.83	20	60	8500	2500	4800	(K)	ADQ
Vicksboro Road (SR 1533):								
NC 39-SR 1519	1.05	20	60	8500	5000	8500	(K)	ADQ
SR 1519-Eest PAB	1.60	20	60	8500	3850	6200	(K)	ADQ
Warehouse Road Extension:								
J.P.Taylor Rd.- Welcome Ave. Extension @ Fuller	0.30	-	-	(12000)	-	5900	H	60
Warrenton Road (SR 1001):								
US 1 Bus.-US 1 Bypass	0.93	26	60	12000	7200	12000	ADQ	ADQ
US 1 Bypass-SR 1509	0.80	24	100	11000	6800	11000	ADQ	ADQ
SR 1509-East PAB	0.90	24	100	11000	5000	10000	ADQ	ADQ
Welcome Avenue (SR 1138):								
Raleigh Rd.-King St.	0.45	18	60	8000	900	5800	(H)	ADQ
Welcome Ave. Extension:								
King St.- Epsom Road	0.35	-	-	(12000)	-	6800	H	60
Western Outer Loop:								
Bear Pond Rd-Belmont Dr.	1.50	-	-	(35000)	-	13000	F	110
Belmont Dr.-Ruin Creek Rd	2.50	-	-	(35000)	-	25000	F	110
Young Avenue:								
Chavasse St.-Parham St.	0.60	26	45	12000	3700	5800	(H)	ADQ
Parham St.-Roanoke Ave.	0.70	20	45	9000	3700	5800	(H)	ADQ

APPENDIX E: TYPICAL THOROUGHFARE CROSS SECTIONS

Cross section "A" illustrates a fully controlled access four-lane freeway. Rural Interstates typically have this cross section. The 12 feet lanes, wide median and wide shoulders provide for maximum speed, efficiency, and safety for travellers.

Cross section "B" illustrates a seven-lane urban roadway. This cross section should only be limited to situations when right-of-way is severely restricted and additional capacity is needed on an existing five-lane roadway. When the conditions warrant six through lanes, cross section "E" is preferred.

Cross section "C" illustrates a five-lane urban roadway with four through lanes and a center turning lane. Turning vehicles crossing the main traffic flow create accident hazards and traffic friction.

Cross section "D" illustrates a six-lane divided with a raised median and partial control of access. The 16 feet median is the minimum recommended for an urban boulevard type cross section. Medians may be landscaped in urban areas when municipalities assume responsibility for the regular landscaping maintenance.

Cross section "E" illustrates an urban four-lane highway with a raised median and partial control of access. The 16 feet median is the minimum recommended for an urban boulevard type cross section. Medians may be landscaped in urban areas when municipalities assume responsibility for the regular landscaping maintenance.

Cross section "F" illustrates an urban divided highway with curb, gutter and partial control of access. This curb and gutter section only uses half of the right-of-way required for the shoulder section and still allows efficient and safe traffic flow.

Cross section "G" illustrates a four lane roadway with no center lane for left turns. When traffic volumes are high, vehicles turning left into driveways block traffic in the through lane. Additional left turn lanes are typically necessary at major intersections.

Cross section "H" illustrates a three-lane roadway. For two-directional traffic flow, the center lane can be a turning lane. For one-way traffic flow, all three lanes flow in the same direction with a parallel road operating in the opposite direction.

Cross Section "I" illustrates a two-lane road with parking on both sides. Because this facility serves both land use and traffic, it should be designed a minor thoroughfare or a local street.

Cross section "J" illustrates a two-lane road with parking on one side. Because this facility serves both land use and traffic, it should be designed a minor thoroughfare or a local street.

Cross section "K" illustrates a rural two-lane roadway with shoulders. When two lanes will have enough capacity through the design year, but may ultimately need additional capacity, 100 feet of right-of-way are recommended. This allows future local officials the ability to widen the road as much as necessary, up to a four-lane divided cross section with a raised median.

Cross section "L" illustrates a six-lane divided freeway with a grass median and full control of access. The median is 46 feet wide (minimum).

Cross section "M" illustrates an urban eight-lane divided highway with a raised median and partial control of access. Medians may be landscaped in urban areas when municipalities assume responsibility for the regular landscaping maintenance.

The curb and gutter cross sections all illustrate the sidewalk next to the curb with a buffer or utility strip between the sidewalk and the minimum right-of-way line. This permits adequate setback for utility poles. If it is desired to move the sidewalk farther away from the street to provide added separation for pedestrians or for aesthetic reasons, additional right-of-way must be provided to insure adequate setback for utility poles.

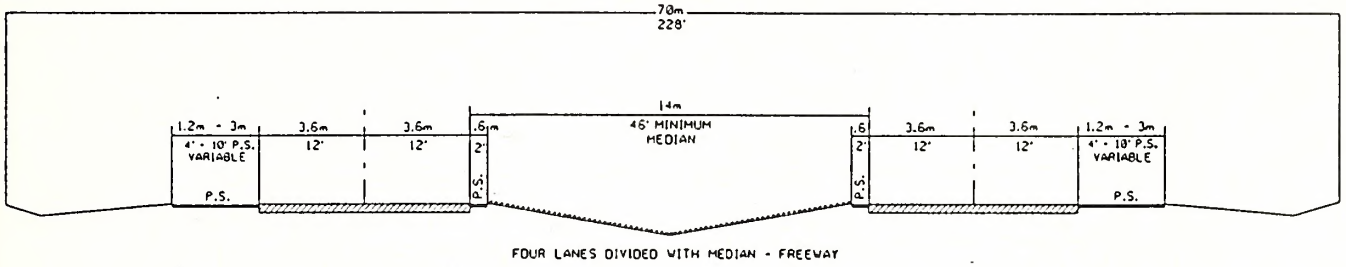
Rights-of-way shown for the typical cross sections are the minimum rights-of-way required to contain the street, sidewalks, utilities, and drainage facilities. Cut and fill requirements may require either additional right-of-way or construction easements. Obtaining construction easements is becoming the more common practice for urban thoroughfare construction.

If there is sufficient bicycle traffic along the thoroughfare to justify a bicycle lane or bikeway, additional right-of-way may be required to allow for the bicycle facilities. Cross sections N, O and P are typically used to accommodate bicycle travel. The Guide for Development of New Bicycle Facilities published by the American Association of State Highway and Transportation Officials details design standards for bicycle facilities.

Recommended typical cross sections for thoroughfares were derived using projected traffic, existing capacities, desirable levels of service, and available right-of-way.

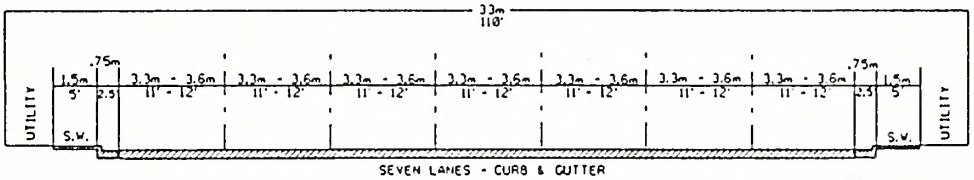
TYPICAL THOROUGHFARE CROSS SECTIONS

A.



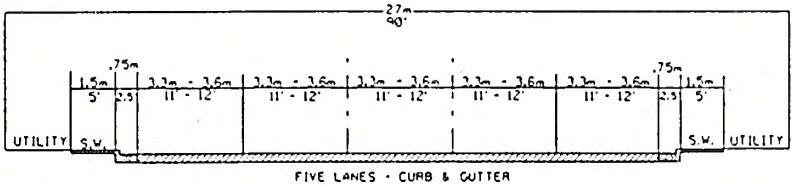
FOUR LANES DIVIDED WITH MEDIAN - FREEWAY

B.



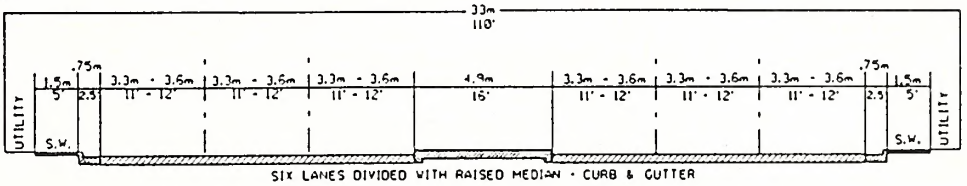
SEVEN LANES - CURB & GUTTER

C.



FIVE LANES - CURB & GUTTER

D.

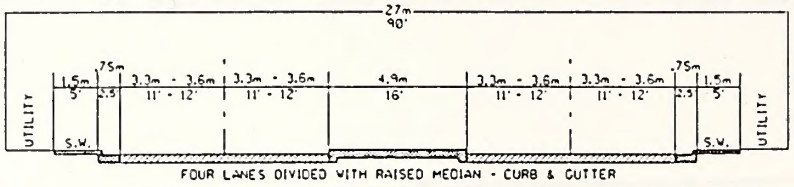


SIX LANES DIVIDED WITH RAISED MEDIAN - CURB & GUTTER

FIGURE E – 1

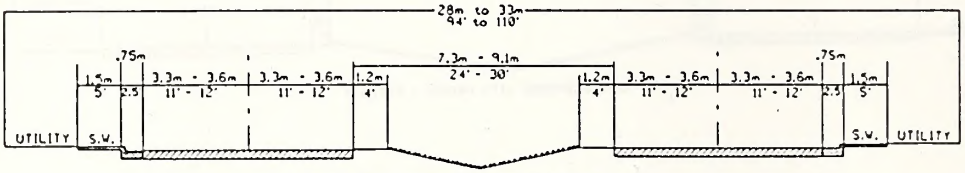
TYPICAL THOROUGHFARE CROSS SECTIONS

E.



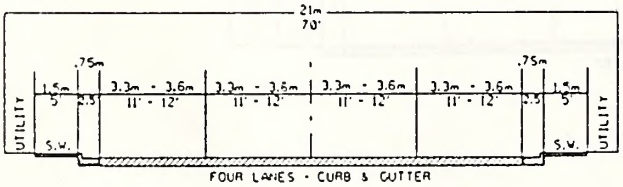
FOUR LANES DIVIDED WITH RAISED MEDIAN - CURB & GUTTER

F.



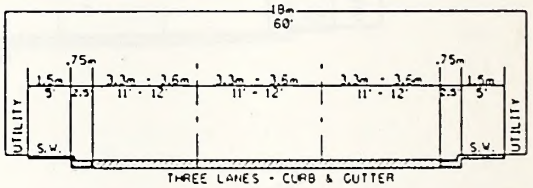
FOUR LANES DIVIDED - BOULEVARD
GRASS MEDIAN

G.



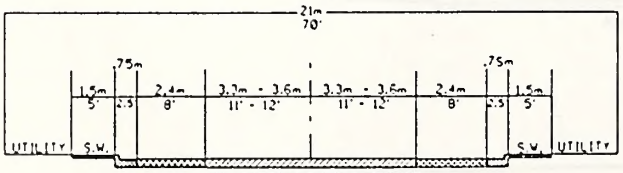
FOUR LANES - CURB & GUTTER

H.



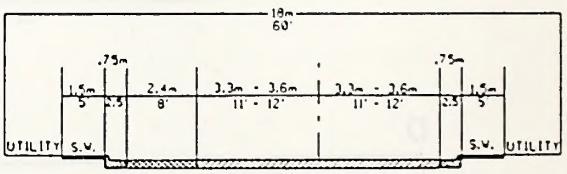
THREE LANES - CURB & GUTTER

I.



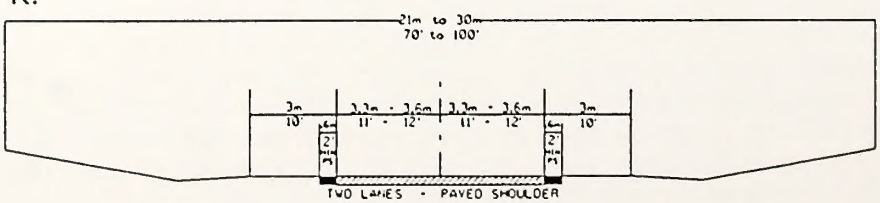
TWO LANES - CURB & GUTTER
PARKING ON EACH SIDE

J.



TWO LANES - CURB & GUTTER
PARKING ON ONE SIDE

K.

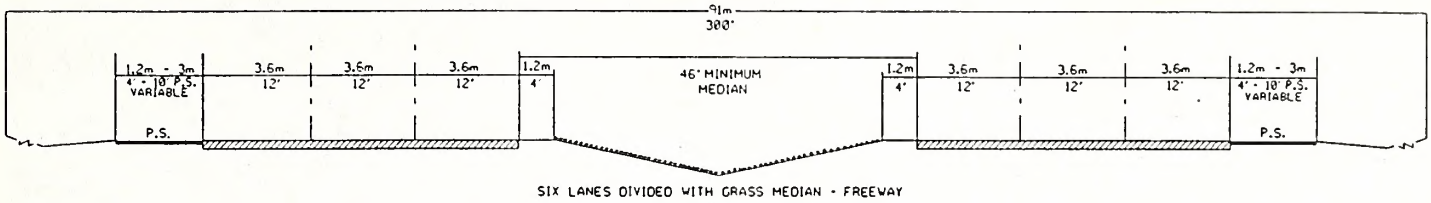


TWO LANES - PAVED SHOULDER

FIGURE E – 1

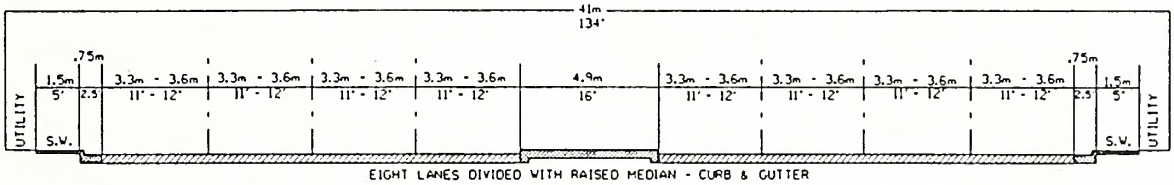
TYPICAL THOROUGHFARE CROSS SECTIONS

L.



SIX LANES DIVIDED WITH GRASS MEDIAN - FREEWAY

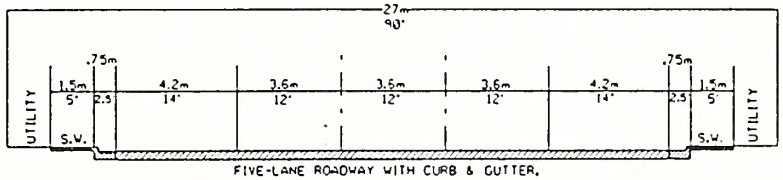
M.



EIGHT LANES DIVIDED WITH RAISED MEDIAN - CURB & GUTTER

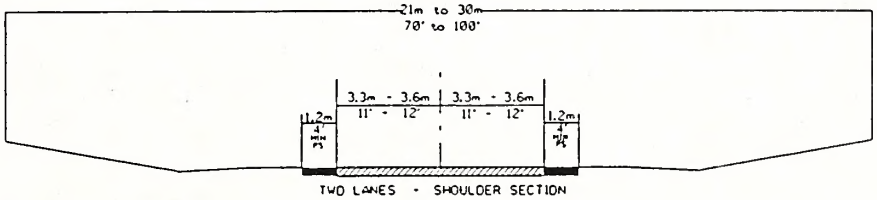
TYPICAL THOROUGHFARE CROSS SECTIONS FOR ACCOMMODATING BICYCLES

N.



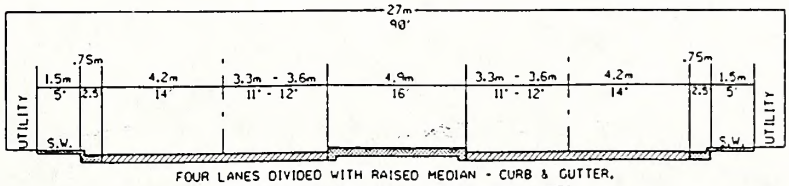
FIVE-LANE ROADWAY WITH CURB & GUTTER,
STANDARD INSIDE LANES & WIDENED CURB LANES

O.



TWO LANES - SHOULDER SECTION

P.



FOUR LANES DIVIDED WITH RAISED MEDIAN - CURB & GUTTER,
STANDARD INSIDE LANES & WIDENED CURB LANES

FIGURE E – 1